THE AMERICAN NATURALIST

VOL. XXXII. *October, 1898.* NO. 382.

THE ANIMALS KNOWN TO THE ESKIMOS OF NORTHWESTERN ALASKA.

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WHEN the United States government, in 1881, decided to occupy two of the stations proposed by the International Polar Conference, it was my good fortune to be attached to the party which was sent to Point Barrow in northwestern Alaska. During the two years which were spent at the station, we had ample opportunity to become familiar with the zoology of the immediate neighborhood, and as we were near two large Eskimo villages, we were also able to obtain much information as to their habits and way of living. It is of the relation between these Eskimos and the animals of their country that I propose to treat in this article.

Before they came in contact with civilized people these Eskimos were entirely dependent on the animal kingdom for their food and clothing, and indeed for a large part of their weapons and implements ; and practically the whole of their existence was spent either in the chase itself, in making ready for the chase, or in preparing the products of the chase for use. These conditions were but little changed at the time of our visit. Except for the almost complete replacement of the bow by the repeating rifle, and a few other less important changes,

we found their habits and customs essentially the same as they were when described by the surgeon of the English ship "Plover," which wintered at Point Barrow during the Franklin search expeditions in the seasons of 1852–54. Since our time, however, numerous parties of white men have lived continuously at the Point, engaged in shore whaling and trading, and of late years there have been missionaries and a school-teacher there, so that, as I am informed, affairs are very different from what we saw then. What I have to say, therefore, must be understood to apply only to the time of my own personal experiences.

The country which these people inhabit forms the extreme northwestern angle of the continent of North America. The permanent winter villages are all on the strip of coast which runs northeast from Kotzebue Sound and terminates in the sandspit of Point Barrow. The shore of the Arctic Ocean east of this point is uninhabited until we reach Herschel Island, in British territory, near the Mackenzie River, though, in their summer wanderings, the people from Point Barrow often went as far east as the Colville River, and sometimes to Herschel Island. On the sandspit at Point Barrow there is a large village, and eleven miles down the coast, at Cape Smyth, another almost as large, near which our station was situated. These two villages formed practically one community. The next village was 70 miles further down the coast, near Point Belcher. The Point Barrow natives had but little to do with this village and practically nothing with the more distant ones. Their knowledge of the interior was confined to a somewhat limited region 75 or 100 miles inland, whither they went in early autumn and late winter to hunt reindeer on the upper waters of the large rivers which empty into the Arctic Ocean east of Point Barrow. The country is a rolling plateau of slight elevation, presenting the general appearance of a country overspread with glacial drift. Small lakes and ponds, which are sometimes connected by inconsiderable streams, abound, becoming more numerous as the land grows lower towards the north. Along the shore line the plateau terminates in steep banks of clay, gravel, and pebbles, looking much like glacial drift, bordered by a narrow steep beach

of pebbles and gravel, and broken at intervals by steep gullies, in which streams run when the snow is melting, and by long narrow and shallow lagoons. These cliffs end at Cape Smyth, where the land becomes low and marshy, and the shore line is continued as a pebbly beach which runs out to form the sand-spit at Point Barrow. Noticeable on this beach are the heaps of gravel which are raised by the ice sometimes 5 to 6 feet in height. Masses of old ice, loaded, as is often the case, with transported material, are pushed up on the beach during severe storms, and melt rapidly in the summer, depositing their load of gravel and stones in heaps. These ice masses are often pushed up out of reach of the waves, so that the heaps of gravel are left thenceforth undisturbed.

Inland the land rises, but very gradually, and the first really broken and hilly ground is decidedly beyond the usual deer-hunting grounds. There are no rocks *in situ* visible in this region, and large boulders are absent. The surface of the ground is covered with a thin soil, which supports a rather sparse vegetation of grass, flowering herbs, creeping willows and mosses, and is thicker on the higher hillsides, forming a layer of turf about a foot thick. Sphagnum abounds in the marshy lowlands. The whole surface of the land is exceedingly wet in summer, except the higher knolls and hillsides. The surface, however, thaws only to a depth of at most 18 inches. Beyond that, the ground is perpetually frozen to an unknown depth.

The climate of this region is thoroughly arctic, the mean annual temperature being 8° F., ranging from 65° to −52° F. The ordinary winter temperature, from December to March, is between −20° and −30° F., rarely rising as high as zero, and still more rarely going beyond it. The worst gales of the year usually occur in January.

The sun is entirely below the horizon for 72 days in winter, beginning November 15, but the midday darkness is never total, even at the winter solstice, as the sun in that latitude is not far below the horizon. Still, the time when one can see to do outdoor work is merely a twilight from 9 A.M. to 3 P.M. Of course for 72 days in summer the sun never sets, and for about a month before and after this time the daylight really lasts all

night. But little snow falls during the winter, and this is so fine and dry that the wind keeps it constantly in motion, forming deep and hard drifts under all the banks, while many exposed places are swept entirely clean. The snow begins to soften and melt about the first week in April, but the ground is not wholly bare before the middle or end of June, while drifts last all summer in some of the gullies. It is on such snow banks that I have seen the patches of "red snow" (*Protococcus nivalis*) looking like claret spilled on the snow.

The sea is usually closed by freezing and the moving in of the pack ice from the middle of October to the end of July. The pack seldom moves far offshore, and there is usually much floating ice all summer. The incoming heavy ice generally grounds on a bar parallel to the shore, and about 1000 yards distant from it, forming a "land floe" of high, broken hummocks, inshore of which the sea freezes over smooth and undisturbed by the pressure of the outside pack, which is usually very rough, consisting of fragments of old and new ice of all sizes thrown together in indescribable confusion. During the early part of the winter this pack is seldom at rest, sometimes moving northeastward with the prevailing current and grinding along the edge of the land floe, sometimes moving off to sea before an offshore wind, leaving "leads" of open water, which in calm weather are immediately covered with new ice (at the rate of 6 inches in 24 hours), and again coming in with greater or less violence against the edge of this new ice, crushing and crumbling it up against the edge of the land floe. The westerly gales of the late winter, however, bring in great quantities of ice, which pressing against the land floe are pushed up into hummocks and grounded firmly in deeper water, thus increasing the breadth of the fixed land floe until the line of separation between this and the moving pack is 4 or 5 or sometimes even 8 miles from shore. The hummocks of this broad land floe show a tendency to arrange themselves in lines parallel to the shore, and if the pressure has not been too great there are often fields of the ice of the season not over 4 feet thick between the ranges of hummocks. After the gales are over, the pack is generally quiet till about the middle of April, when easterly

winds are apt to cause leads to open between the land floe and the pack. These leads now continue to open and shut, varying in size with the direction and force of the wind, until the land floe itself begins to melt and break away, and finally all moves off together. Meanwhile the level shore ice has first "rotted" through in holes, and finally broken up into small floes which join in the final moving off. I have dwelt particularly on these details of the behavior of the ice, because the habits of the marine mammals, and consequently the practices of the Eskimos, are largely governed by the conditions of the ice.

It may be stated as a general principle that it is the presence of the marine mammalia, the seals, walruses, and whales, which enables the Eskimos as a race to maintain their existence in the barren region which they inhabit. Hence, wherever we find Eskimos, we find them making their permanent homes along the seacoast, and leaving the shore only for short expeditions in pursuit of reindeer or musk ox. So far as I know, there is but one instance of an Eskimo community — a relatively small one — which makes its permanent home at any distance from the seacoast, and even these people are obliged to resort to the coast every summer to renew their supplies of oil and other necessary articles. In different regions, different marine animals form the mainstay of the Eskimo's existence. At Point Barrow the animal of primary importance was the smallest of the seals, *Phoca fœtida*, the rough or ringed seal, the Netyik of the Eskimos. Its flesh was the great staple of food, while its blubber supplied fuel for the soapstone lamps which lighted and warmed the winter houses, and its skin served countless useful purposes. Except for the need of some substance of which weapons and other implements could be made, like the ivory of the walrus or the antlers of the reindeer, more or less helped by a supply of driftwood, an Eskimo community would need nothing more than this seal to support existence. It was the only animal which could be taken at Point Barrow in reasonable abundance at all seasons of the year, and a scarcity of seals in winter, due to unfavorable weather, was often the cause of serious hardship, and not seldom of actual famine. Next in importance to the seal was the reindeer. As this animal was

very abundant within the usual range of the Point Barrow Eskimos, they were in the habit of clothing themselves almost exclusively in reindeer skins, which are the most admirable material yet found for cold-weather clothing. Reindeer venison was a highly prized luxury, the antlers furnished material for all sorts of implements, while the long tendons of the back and legs were dried and split up into thread for sewing garments. The only other animals of great importance to these Eskimos were the walrus and whale. Although the latter animal was by no means essential to their existence, nevertheless the capture of several large whales every season added most materially to their comfort, and made them far more prosperous than most of the Eskimo communities with which we are familiar.

Let us now consider the habits of these animals somewhat in detail, taking up first the seals, walrus, and whales, then the bears and other beasts of prey, and next the other land mammals and the birds. The ringed seal was the most abundant of all the seals, in fact the only one which could really be called common, but as they are chiefly to be found in the neighborhood of the ice, they were rarely seen in summer when the sea was clear. When, however, much loose ice was running, seals were always to be found in plenty and many were shot from the umiaks. They were also sometimes captured in stake nets in the shallow bays east of Point Barrow. After the sea began to close they became quite abundant, resorting for air to the open pools amongst the pack. At this season most of the hunters were out every day, carrying a rifle and a small harpoon suitable for throwing, with which they retrieved such seals as they succeeded in shooting. At this season of the year there is considerable danger in going out upon the ice, as a sudden shift of the wind frequently carries out to sea large portions of the still loose pack. The natives used to be very careful not to leave a crack between themselves and the land if the wind, however light, was blowing offshore, but, in spite of their care, men were every now and then carried off and never seen again. At this season of the year, as I have said, a single calm night is sufficient to cover any open water with young ice strong

enough to bear a man. In this young ice the seals make perfectly round holes about the size of a quarter of a dollar, and return to these holes every now and then to take breath. When young ice formed, the hunters used to watch at these breathing holes, standing upon a peculiar little three-legged stool, and using a harpoon with a slender shaft suitable for thrusting through the hole to secure the seal when shot. The fields of young ice last but a few days at a time before they are broken up by the movements of the pack, and the seals do not often have a chance to make regular breathing holes, but depend for fresh air on the irregular crevices among the cracked and splintered ice hummocks. When a hunter discovered such a crevice, he used to set his nets all round it under the ice, and frequently kept them there all winter, visiting them every few days. Many seals were taken in this way. But by far the greatest number of seals was taken in the night netting, which began with the departure of the sun, and could only be carried on successfully on the very darkest nights. The natives told us that even a bright aurora interferes with their success. When a lead of open water appeared, nearly all the men of the village would resort to it with their nets, which they set wherever they found the ice tolerably level and not too thick for about 100 yards back from the lead. These nets are of stout sealskin thong about 15 feet long by 10 deep, and are set under the ice in such a way that they hang down, like a curtain, and can be drawn up through a hole large enough to allow the passage of a seal's body. A number of nets were often set close together. When the night grew dark enough, the hunters would begin to rattle on the ice with their ice picks, whistle, or make some other gentle and continuous noise, which soon excited the curiosity of the seals that were swimming about in the open lead, until they would finally begin to dive under the ice and swim towards the sound, which of course led them directly into the nets. On favorable nights a great many seals were taken in this way. For instance, on the night of Dec. 2, 1882, the netters from the Cape Smyth village alone took at least 100 seals. As at this season the weather is often excessively cold, the dead seals freeze stiff very soon. If sufficient snow had

fallen, the frozen seals were stood up by sticking their hind flippers in the snow to keep them from being covered up and lost if the snow began to drift, and they were left until it was convenient to send out the women for them with dog sledges. I once counted 30 seals, the property of one native, standing up together in a single stack. The night netting comes to an end when the winter gales close the leads permanently. After the sun comes back in the spring there are frequently to be found among the hummocks curious dome-shaped snow houses, about 6 feet in diameter and 2 or 3 feet high, with a smooth round hole in the top and communicating with the water by a large passageway. They look curiously like the work of man, but they are really made by the female seals. In these they bear their pups in the early spring, but after the young have grown large enough to swim about by themselves, they apparently resort to the nearest house when they want to take breath. At all events, the Eskimos used to stretch a net across the opening of one of these houses, when they could find one, under the ice, and often caught a number of seals in succession at the same hole.

In June and July, when the ice becomes rotten and worn into holes, the seals crawl out upon the ice to bask in the sun. At this season of the year they were excessively wary, but were occasionally stalked and shot. The harbor seal (*Phoca vitulina*) was well known to the natives under the name of Kasigia. They said that it was occasionally taken in the stake nets in summer, but was more plentiful near the villages at Point Belcher. To our great surprise, among the seals taken in the night netting in 1881 was a single male of the curious and beautiful ribbon seal (*Histriophoca fasciata*), not previously known to occur north of Bering Strait. It was, however, well known to the natives, although said to be very rare. The great bearded seal (*Erignathus barbatus*), whose skin is specially prized for making harpoon lines, boot soles, boat covers, etc., was never very abundant, and occurred chiefly in the season of open water. Two, however, were taken at breathing holes in the rough ice on Jan. 8, 1883. At the time of our visit, the walrus, which is the species distinguished by Allen as the Pacific

walrus (*Odobænus obesus*), was far from abundant, although they were frequently seen during the season of open and partially open water, swimming about amongst the loose ice or asleep on floating cakes of ice, either alone or in small herds. The natives pursued them in their large skin boats, using a heavy harpoon with a float of inflated sealskin attached to the line, but employing the rifle freely whenever opportunity offered. During the summer of 1883, they had taken about a dozen up to the middle of August.

The polar whale (*Babæra mysiticetus*), the "bowhead" of the whalemen, occurred near Point Barrow only during the spring migrations, when they were traveling northward to their breeding grounds near the mouth of the Mackenzie River. They appeared first as stragglers when the leads began to open about the middle of April, gradually increased in numbers, and continued to pass until about the first of July. Except when the leads were wholly closed, whales were continually passing at this season, even when the leads were full of loose ice. Indeed, the whales seemed to have learned that they were much safer among the ice floes than in the open water, and could often be heard blowing in the loose pack, when there was a broad open channel for them to travel in. On the return migration, which begins about the middle or end of August, they pass by at a long distance from the land. Consequently, the natives pursued them only during the spring migrations. About twenty umiaks, carrying each a crew of eight or ten men, were fitted out at the two villages and dragged on sleds out across the rough ice to the edge of the open water. This whale fishery was the great event of the year, eagerly anticipated and carefully prepared for. It was even invested with a semi-religious character, by a series of elaborate ceremonies and a complicated system of tabus and observances. The umialiks, or owners of umiaks, who were all men of great importance in the village, wore peculiar ornaments, and the crews were carefully selected and regularly hired for the whole season. Whenever there was open water and any prospect of whales, the crews spent the whole time on the ice, while the women traveled backwards and forwards from the village with

their food, and the boats were not brought in till the close of the season. Each boat was supplied with several harpoons, to each of which was attached a short line and a pair of floats made of inflated sealskins, and their plan was to attach so many of these floats to the whale at successive "risings" that he could no longer sink, and they could then paddle up and despatch him. They formerly used stone-headed lances for this purpose. We brought home one, a magnificent piece of flint chipping as big as the palm of my hand, mounted on a shaft 13 feet long. At the time of our visit, however, they were all supplied with regular steel whale lances, and some even had bomb guns.

The dead whale was at once towed to the edge of the solid floe, and all hands — men, women, and children, for the news was never long reaching the village — set to work to cut off all the blubber and meat they could get at. Not seldom the whale sank, or was carried off under the ice, before they succeeded in securing more than a part of the blubber. Every one in the village was entitled to all the meat, blubber, and "blackskin" that he could get, but the whalebone, which had a commercial value, was divided equally among the boats that were in sight when the whale was struck.

The "blackskin," or epidermis of the whale, which is about an inch thick and of a somewhat India-rubber-like consistence, is esteemed a great delicacy, as indeed is the case among all Eskimos who can obtain it. In favorable seasons as many as ten or a dozen whales have been taken, and bones of the whale are plentifully scattered all along the shore and in the village, where jawbones and ribs were used for posts and staging timbers.

Each season of open water, one or two large schools of white whales passed along near the shore, and the Eskimos usually shot a few every year. They were highly prized, not only for their flesh and blubber, but for their skins, which make the best material for waterproof boot soles, and, when plenty, were rarely used to make a very superior quality of harpoon lines. We found that the natives had a good deal of narwhal ivory, easily recognized by its spiral grain, and they informed us that

they occasionally saw the animals. They are, however, very rare, as we saw or heard of none during our stay.

Polar bears were by no means so abundant about Point Barrow as might be expected, and they appeared to confine themselves almost entirely to the ice field at some distance from the shore. Only one of us was lucky enough to see a bear, just making his escape into the moving ice, pursued by all the dogs and half the men and women of the village. The seal hunters shot several bears while we were there, and once or twice during the winter hungry bears came into the village, attracted by the stores of seal meat, and were immediately surrounded and shot. As a rule, however, they were exceedingly anxious to escape when they encountered men or dogs, and we only heard of one or two that showed fight or came to bay. The bears killed in winter were beautifully clean and white, but in summer they grew very dirty and brown. There is a real brown bear, which they sometimes killed inland on the rivers, and they showed us several robes which were the color of the cinnamon bear. It is probably the barren ground bear (*Ursus richardsoni*).

Though the wolf (*Canis lupus griseoalbus*) was well known to the natives, who highly prized the fur for trimming their deerskin garments, it seldom or never appeared on the coast, but was confined to the reindeer country, where, according to the natives, it was very abundant, pursuing the deer in packs.

In the same region they occasionally captured red or black foxes (*Vulpes fulvus fulvus* and *V. f. argentatus*), though most of the skins of these animals in their possession were obtained by trade from the Eskimos whom they met at the Colville River, as were also the skins of the wolverine. The tail of the latter animal is a very important article to the Eskimos of the northwest, for fashion insists that every man shall wear one attached to his girdle behind. If a wolverine's tail is not to be had, the bushy tail of a dog or fox is worn, but it is not considered so fashionable.

Every male must also wear dangling from the back of the jacket, between the shoulders, the skin of an ermine, though this perhaps was more a kind of amulet or *porte-bonheur* than

an ornament. Some, at least, of these ermines are caught near the villages. But of all the fur-bearing animals, the most abundant is the Arctic fox (*Vulpes lagopus*). During the winter the snow was covered with their tracks, which were sometimes noticed far out on the ice, where they had probably been playing the jackal to the bears. They are, however, so exceedingly shy and so well protected by their white coats that they were seldom seen at this season. In summer they were frequently seen quartering the ground like a dog, hunting in search of birds' nests, and, when alarmed, ran with exceeding swiftness, seeming barely to touch the ground. They were, in general, pretty widely scattered over the country, but occasionally congregated in great numbers where carcasses had been washed ashore. If a reindeer were killed that could not be brought in overnight, it had to be carefully covered up with slabs of snow, or the foxes made short work of it. The natives took many of them in winter by building little houses of snow in which they placed a bait, burying a steel trap in the snow at the threshold, or arranging a deadfall so as to be sprung by any animal forcing his way through the narrow entrance. Our trader obtained a large number of white fox skins, mostly in fine condition, with very heavy thick fur. Among them were one or two "blue" skins also in fine winter pelage.

The reindeer of this region is the well-known barren ground caribou (*Rangifer tarandus grœnlandicus*), known to all Eskimos as *tuktu*. This animal did not come down to the coast near Point Barrow in any numbers. Straggling individuals and small herds were occasionally seen during the summer wandering about the plain, and sometimes came down to the beach or took water in the lagoons, especially on calm, sunny days when the flies were troublesome. During the rutting season in the latter part of October, a good many were to be seen roaming about a few miles inland, but they were excessively wild, though the rutting bucks were rather inclined to be curious and came towards a man who kept perfectly still. Later in the winter, from January on, small herds were often seen a few miles from the villages, and we often saw their tracks and the places where they had scraped off the snow to get at the moss.

Two or three hunters were out on snowshoes nearly every day at this season. In the utter absence of anything like cover, stalking was absolutely out of the question, and their practice was to travel straight after the deer as fast as they could. Sometimes the deer would go straight away at such a pace that they would make good their escape, but in most cases their curiosity would get the better of them, and one or more would begin to circle round to get a better view of the pursuer, who would immediately alter his course so as to head them off. As soon as he got within 500 or 600 yards, he would open fire with his Winchester, and keep it up until the deer was killed or driven away. Strange as it may seem, many deer were killed in this fashion. The natives were very lavish of their ammunition, and their reckless shooting had already made the deer very wild. Most of the deer, however, were obtained at the inland hunting grounds already referred to. Many of the natives used to go to these grounds in the autumn, as soon as enough snow had fallen to make sledging practicable, and remained there until the days grew too short for hunting. At this season they found the deer abundant and moving about in large herds. According to their account, the deer left this region and went further inland when the winter night set in, and did not return till about the first of February, when with the return of the sun the great deer-hunting season began. At this season half the village used to resort to the rivers, where they encamped in permanent and comfortably fitted up snow houses, usually in small parties of two or three families each, at some distance from each other. Here they stayed until it was time to return for the whaling, usually about the end of March or the middle of April. The men spent all the available daylight hunting deer, while the women occupied themselves dressing skins and fishing through the ice of the river, usually with excellent success. Heavy loads of frozen meat and fish and rough-dried skins used to be brought in, and the return of the hunters was always celebrated with great feasts, when the pot was kept boiling all day long and every visitor was entertained with venison. The does drop their fawns in the spring somewhere not far eastward of the Point. At this season the Eskimos

were busy with the whale fishery and paid no attention to the deer, but when the fawns were about a month old, small parties used occasionally to go off in quest of fawn skins for making fine garments and trimmings. They told us that they were able to catch the fawns by running them down. In warm weather, when the deer took to the water to escape the flies, they were still chased in kaiaks and killed with a light lance, in the manner so generally practiced by the Eskimos.

These Eskimos had many garments made of the skin of the mountain sheep, and water dippers were very generally made from the horns of this animal, which is the light-colored form known as *Ovis canadensis dalli*. Most of this material was doubtless obtained by trade, but some of our acquaintances had hunted the sheep in high rocky ground, "eastward — far away."

Lemmings, both *Cuniculus torquatus* and *Myodes obensis*, occasionally appear in great abundance. In 1882 we saw none, but the natives began to catch them in January, 1883, and through the season we saw plenty of them. As they spend most of the time in the tunnels which they make in the moss and under the snow, they are seldom seen in winter, except during drifting snowstorms, when the snow over their burrows is probably blown away. The Eskimos believe that at such times they have come down from the sky, whirling round and running about in spirals as soon as they touch the ground. The first one that we obtained was brought in by an Eskimo, who told us, "There are none here on the land. As it was bad weather he fell down from above."

Compared to the mammals, the birds of the region were of little importance to the Eskimos, though they knew and distinguished by name nearly all the species which we found to occur there. During the spring enormous numbers of eider ducks used to pass up the coast, on the way to their breeding grounds in the east, and a few scattering pairs remained to breed. These were mostly of two species, the king eider (*Somateria spectabilis*), which were the first to appear in the migrations and were the most abundant, and the Pacific eider (*S. v-nigra*). Later than the eiders came the great flight of

long-tailed ducks, oldsquaw (*Clangula hyemalis*), flying high, with great clamor, and many of these remained to build about the ponds and little pools. At these pools were also sometimes found the curious spectacled eider (*Arctonetta fischeri*) and the beautiful little Steller's duck (*Eniconetta stelleri*). Three species of geese were also rather plenty and bred. These were *Anser albifrons gambeli*, *Chen hyperboreus*, and *Branta nigricans*, and we rarely saw swans. All through the open season the large burgomaster-like gull, which Mr. Ridgway has described as the Point Barrow gull (*Larus barrovianus*), was very abundant, and the rare and beautiful rosy gull (*Rhodostethia rosea*) appeared in multitudes for a short time each autumn. Less common were the ivory gull (*Gavia alba*) and Sabine's gull (*Xema sabinii*), while round the sandspits lived many Arctic terns (*Sterna paradisea*). All of these birds, especially the larger ones, were used for food, and each had its distinctive Eskimo name. Of less importance were the three species of loons, the few guillemots and skuas, and the many species of wading birds, such as the plovers and sandpipers. Of land birds, the most familiar are the little snow bunting (*Plectrophenax nivalis*), the first bird of the Arctic spring, the little bird who "by and by," said they, "will sit upon a stake and *talk loud*," the Lapland longspur (*Calcarias laponicus*), and two species of grouse, the willow grouse (*Lagopus lagopus*) and the rock ptarmigan (*Lagopus rupestris*), both of which remain all winter, turning white for protection, like the foxes. When the lemmings come, the snowy owls follow them.

As I have already said, the Eskimos paid but little systematic attention to the birds. They shot them when opportunity offered, and the women and children collected all the eggs they could find near their summer camps, but as a general thing the men were too busy to waste time on birds. Towards the end of the summer, however, when they were all gathered at the camp ground, just where the sandspit of Point Barrow leaves the mainland, they really devoted themselves to duck shooting in the intervals of dancing, feasting, and trading with their visitors from the Colville and the sailors from the ships. At this season the ducks are returning in large flocks from the

east, hugging the shore of the mainland, and when they reach the beach, either fly out to sea across a narrow place just above the camp, or else turn and follow the line of ponds which lie just behind the beach. Just at the point where the birds usually turned, the Eskimos had set up a row of posts reaching to the tents. Then on favorable days they concealed themselves in shallow pits dug in the narrow ridge above the camp. When a flock of birds reached the right spot, the gunners would set up a shrill yell. Frightened by this and by the line of posts, for they fly low, nine times out of ten the ducks would falter, become confused, and finally collecting into a compact body, would whirl along the line of posts, past the tents, flying close to the water, and turn out to sea at the first open space, which is just where the gunners are posted.

When the eiders were flying during the spring migration, not a man, woman, or child of either village ever stirred outdoors without at least one set of bird bolas. This weapon, with its six ivory balls, they used with considerable skill, though I have often seen it thrown at foolishly long range. It is a curious sight to see a duck settle down out of a flock, as the twisting cords wind themselves round his wings.

We have now enumerated all of the most important mammals and birds with which these Eskimos were acquainted, and have pointed out the different ways in which they were in the habit of making use of them. Much that would be interesting might be said about the fishes of the region, as well as what the Eskimos told us of what they thought about the lower animals, but space will not permit.

METHODS IN PLANKTOLOGY.[1]

GEORGE WILTON FIELD.

HUMAN existence is dependent upon the oceanic fauna and flora far more than is generally suspected. Scientific investigation has demonstrated a most remarkable biological chain and has elucidated the links which connect the lowliest of the microscopic plants with the most highly developed mammals. In the continual cycle of matter from inorganic to organic, from organic to inorganic, with the attendant alternate storing up and liberation of energy, are to be found the secrets at the basis of life. It is commonly held by biologists that life originated in the sea ; and it is in the sea to-day that we find those plants and animals which have departed least from the original, the ancestral condition, in which life is not complicated by diversity of form or function.

Some of the work carried on by the biological department of the Rhode Island Experiment Station has been upon the Methods of Studying the Œcology of Marine Organisms, since a knowledge of the marine organism is of immense importance in understanding the questions connected with the fundamental food supply on the earth.

The number and variety of the animal and vegetable population of the ocean are well-nigh infinite. Any two regions more or less remote from each other show differences in their oceanic fauna and flora, generally proportional to the distance either horizontal or vertical which separates them. The fauna and flora of the tropical Caribbean Sea differs widely from that of the Arctic oceans ; that of the water south of Cape Cod differs markedly from that north of the Cape, though separated only by a very few miles of land. The organisms characteristic of the surface in any region are wonderfully different from those of the abyssal depths. Yet even in the same locality remarkable

[1] Reprinted from the *Annual Report of the R. I. Agricultural Experiment Station*, 1897.

variations are the rule. These variations are conditioned not only by temperature, specific gravity, atmospheric pressure, and light, but probably by fundamental phenomena of which science as yet knows nothing. Certain forms spend the day in the depths, appearing at the surface only at night; for various forms the reverse is true. There are other temporal differences, — yearly, monthly, daily, and hourly variations, — whose causes are manifold, in part climatic or meteorological, in part depending upon the conditions of life, of reproduction, and development. Still other variations are brought about by the numberless currents great and small, which not only collect the organisms into eddies and scatter the "schools," but transport organisms characteristic of one region to places far remote from their home, *e.g.*, the Gulf Stream carries tropical forms far into the cold northern seas.

All the organisms which are borne about helplessly by currents, or whose motions are determined by protoplasmic activities (heliotropism, chemiotropism, etc.), as distinguished from special and effective locomotory organs, constitute the Plankton (a word coined by Professor Hensen from the Greek πλανᾶσθαι, to wander). The Plankton has attracted naturalists since the studies of Johannes Müller, but Professor Hensen was the first to give earnest attention to the economic importance of the Plankton, and to the problems of the food supply based upon it. He was led to this through his attempt to get an approximate idea of the number of fish in corresponding districts. This work brought him to the question of the food supply for these fishes, and from that to consideration of the general primary sources of food and the cycle of matter in the ocean. This has led to important results in tracing the cycle of changes through which the organic elements, carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, iron, and others pass; in showing how they either singly, or united in simple combinations, become incorporated into a living (it may be microscopic) plant; how this plant is eaten by a mollusc or a small fish, a prey in turn for larger and fiercer fish, which ultimately die and are broken up by microscopic plants (bacteria) into the original elements, to again nourish plants. The actual cycle is rarely so simple as

described above. Complicating conditions usually appear at every stage. Naturalists are gradually unraveling these complications. But the point which is of special importance is that very many of these marine animals may furnish economical, healthful, and delicious food for man. That this may be a never-failing source of food supply for an increasing human population, not only must the habits, haunts, and life histories of such food animals (fishes, molluscs, crustacea, etc.) be elucidated, but also their relation to natural phenomena, meteorological conditions, currents, etc., and especially to the Plankton, upon which they depend more or less immediately for food. This necessitates study of the Plankton as the basis of food supply for our most important marine food animals.

The study of the economic aspects of the Plankton and the application of the results to cultivation of water areas have demonstrated that the water responds even more bountifully than land areas to cultivation. It is an interesting economic fact that less than 15 cubic feet of cultivated water is sufficient to support at least the head of a family (and probably a considerable number of other dependents) of Italians in Tarente, while 6 cubic feet do the same in Japan. Numerous experiments demonstrate that the yield of cultivated water area surpasses in essential food elements that of equal area of cultivated land. Herein lies the great importance of a knowledge of the Plankton, the basis of marine life. The Plankton also enters as an important and, in certain aspects, as an undesirable element into the question of municipal water supplies, and the necessity of healthful and palatable drinking water has stimulated not a little the study of the quantitative and qualitative constitution of the Plankton.

Since the time (1884) when Hensen entered upon his work of counting laboriously the number of organisms in known quantities of sea water, for the purpose of ascertaining the amount of living matter which exists in given volumes of water, and thus furnishing a basis for scientific aquaculture, much attention has been given to the methods of Planktology and rapid progress has been made. The great desideratum even now is a rapid, simple method by which data can be

obtained which can be used for comparison of all waters. Not until the invention of such a method can accurate and valuable comparisons be made.

At the basis lies the method of collecting the organisms from an accurately determined quantity of water. An ideal method is one which includes the concentration of the organic matter in a known quantity of water into a smaller known quantity of water, which quantity should be a convenient multiple of the original quantity. In the process not even the smallest of the bacteria should be lost. Counting and enumeration of individuals and species is necessary, together with an estimation as accurate as possible of the volume of the water, of the inorganic matter, and of the organic amorphous débris (plant and animal). The counting can best be done by the Sedgwick-Rafter method (Rafter, G. W., '92). By this method a fairly accurate idea can be formed of the comparative volumetric and numerical proportions between the three main elements involved in the biological study of water; *viz.*, the living organisms, organic amorphous débris, and inorganic substances (silt, gases, and substances in solution). It would seem that the necessary data must be based ultimately upon the counting method until such time as means can be devised for separating the living organic from the dead (both organic and inorganic) substance, and for determining the amount of each. In considering the quantity of living organisms not only the number but also the size of the individuals must be taken into account. Professor Hensen introduced the counting methods for the purpose of determining the economic yield of the ocean in the same way as the farmer determines the useful yield of his fields and meadows, the annual production of grass and grain. Professor Haeckel in stating his objections to this method said: "The farmer determines the yield of his meadows, garden, and field by quantity and weight, not by counting the individuals. If instead of this he wished to introduce Hensen's new exact method of determination, he must count all the potatoes, kernels of grain, grapes, cherries, etc., not only that but he must also count the blades of grass in his plot, even every individual weed which grows among the grain of his field and the

useful plants of his garden, for these also, regarded from the physiological point of view, belong to the 'total production' of the ground." (Translation in Report of U. S. Commissioner of Fish and Fisheries for 1889–91, pp. 565–641, of *Plankton Studien, Jenaische Zeitschrift,* Bd. xxv, 1890.) It would seem as if Professor Haeckel overlooked the fact that the farmer can readily separate the hay, etc., from stones, dead sticks, and other foreign material. He can accurately determine the volume and weight of farm products. He does not have to contend in this connection with foreign substances, such as silt, organic débris, etc., which render inaccurate determinations by weight and volume of the contents of water from ponds, lakes, and oceans. It is these elements which thus far have prevented any apparent progress in establishing tables of the economic yield of water volumes on the basis of weight, volume, and number of individuals, which would be of value for comparison in determining the commercial importance of any area or any depth of water.

It is, too, the presence of an undetermined and locally varying quantity of organic débris which renders inaccurate the estimation of the economic value of water by means of the determination of the albuminoid ammonia.

Numerous methods of Plankton collecting have been devised; the most important of these may be grouped as follows:

(1) By drawing a fine net through known volumes of water.

(2) By passing known volumes of water through a filter of either (*a*) fine silk bolting cloth, or (*b*) fine sand, or (*c*) a combination of *a* and *b*.

(1) The net and the method of using it have been subjected to much study by Hensen (**'87** and **'95**), Apstein (**'91**, **'92**, and **'96**), Reighard (**'94**), Ward (**'96** and **'96a**), Borgert (**'96**), Kofoid (**'97**), and others. From the net method it seems impossible to exclude several prolific sources of uncertainty in the results; *viz.*, (*a*) it is impossible to be *certain* of the quantity of water through which the net is drawn, and consequently of the quantity which passes through the net even in motionless water; (*b*) currents in the water almost hopelessly complicate the conditions; (*c*) the progressive clogging of the net cannot be

avoided ; (*d*) there is an actual loss of small individuals through the meshes of the net ; (*e*) the long and complicated process must necessarily give varied results due to personal variations in methods of work, and to changes in the local conditions, *e.g.*, the rate of currents may vary from day to day, the quantity of silt may modify the filtering capacity of the net, etc. Any one of these sources of error is sufficient to invalidate the entire method, rendering the results worthless for comparison with the results of similar processes in different localities.

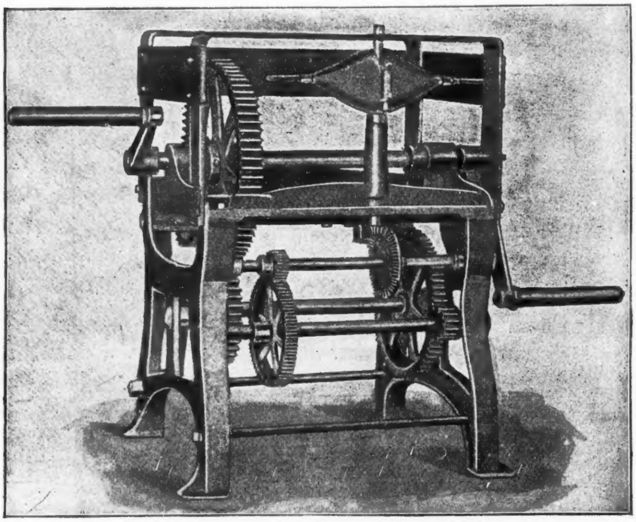
Under (2) (passing known quantities of water through a filter of fine bolting cloth) the sources of error are reduced but not eliminated ; (*a*) the pressure of water forces certain small forms, *e.g.*, certain species of bacteria, through the meshes. Many of the very delicate forms may be broken up and destroyed ; (*b*) failure to wash out all the individuals from the net. The method of pumping known volumes employed by Kofoid ('97) is particularly good. The most apparent source of error is the control of the quantity of water pumped, and the possibility that the strong suction of the pump used may draw mud when the water is taken within a foot of the bottom. In the method of filtration through sand, as employed by Calkins ('91) and as improved by Jackson ('96) and by Whipple ('96), the possible sources of error are several, varying with the characteristics of the sand used, with the shape of the funnel, and with the nature of the organic matter in the water. Calkins says : "The sloping sides of the glass funnel offer a surface for the settling of organisms, and the error arising in this way may be considerable. A water free from amorphous matter and zooglœa will filter very accurately, but a water containing these gives opportunity for error." Jackson ('96) adds : "This is undoubtedly due to the jelly-like character of the zooglœa, and to the fact that while adhering to the funnel sides itself, it also retains with it other organisms." . . . "Not only do amorphous matter and zooglœa readily adhere to the sides of the ordinary glass filter funnel, but the same is true of the gelatinous growths of the Cyanophyceæ and of the flocculent threads of Crenothrix." Even Jackson's ('96) improvements in the sand filtration method which reduce to a minimum

the liability of error cannot remove the defects inherent in the process itself. The defects noted by Whipple ('96) are involved in the method of concentrating the sample, *viz.*—(1) the funnel error, arising from the adherence of organisms and amorphous débris to the sides of the funnel ; (2) the sand error, caused by organisms passing through the sand ; (3) the decantation error, resulting from the adhesion of organic matter to the particles of sand, and from the capillary retention in the sand of the water used in washing the sand during decantation ; to the above should be added (4) the destruction of the very delicate organisms by the sand in the process of decantation. The practical value of the method for comparative results in the hands of different workers is invalidated by the multiplicity of conditions affecting the results; among these are the nature and amount of the sand, the care and skill of the worker, and particularly the nature of the sample to be filtered.

Kofoid (*Science*, vi, 153, Dec. 3, 1897, "On Some Important Sources of Error in the Plankton Method") found that filter paper (No. 575 Schleicher & Schüll) was more effective than the sand filtration method, giving 75% to 85% of the planktonts as compared with 40% to 65% given by the sand filters. Kofoid has detected the advantage of filtration through very delicate porous media, and finds that fine infusorial earth is very efficient, and in spite of minor difficulties connected with the final separation of the planktonts from the infusorial earth he regards this as the most satisfactory method thus far devised. I might add that the total weight of material (organisms, organic and inorganic débris) suspended in water is of fundamental importance and can be determined with considerable accuracy by this method, though I see no way to ascertain the relative proportion of organisms and débris except very roughly through the enumeration of the individual organisms and comparison of the apparent bulk of the masses of living and dead material as seen under the microscope.

Experiments have been made by adding various quantities of either corrosive sublimate, picric acid, acetic, and other acids, alcohol, and formalin to known quantities of water, with a subsequent determination of the volume and constituent elements

of the precipitate. The space required, the tediousness, the loss of organisms, the fact that in this new process very many forms break up before all the material is settled have led to its abandonment in favor of the employment of centrifugal force. Prévious to 1896 Cori devised a simple hand centrifuge and used it for collecting infusoria for class work. Last year a brief reference was made to our work with the centrifugal



The Planktonokrit.

method (Field, '97, I). Since then Kofoid ('97) has experimented on similar lines. His machine is "geared to give 3000 to 4000 revolutions per minute and arranged to act upon a continuous stream of water, all of which was subjected to the maximum and uniform action of the centrifugal force." This machine secured in some instances 98% of the planktonts. But as I pointed out last year, it is not so efficient with those organisms whose specific gravity is about that of water, such as the Cyanophyceæ, Anabœna, Clathrocystis, *et al.*

Experiments have been made with the centrifugal machine devised by Dr. C. S. Dolley, called the Planktonokrit, and

described by him (Dolley, '96) : "An apparatus which consists of a series of geared wheels driven by hand or belt, and so arranged as to cause an upright shaft to revolve to a speed of 8000 revolutions per minute, corresponding to 50 revolutions per minute of the crank or pulley wheel. To this upright shaft is fastened an attachment by means of which two funnel-shaped receptacles of one liter capacity each, may be secured and made to revolve with the shaft. The main portion of each of these receptacles is constructed of spun copper, tinned. To this is attached the stem of the funnel, consisting of a heavy annealed glass tube of 15 mm. in outside diameter with a central bore of 2½ to 5 mm. These glasses are held in place and protected by a cover, such as is employed in mounting a water gauge.

"The receptacle having been filled with the water to be examined, is caused to revolve for one or two minutes, when the entire contents of suspended matter in the water is thrown down to the bottom of the tube, from which the volume may be read off by means of the graduated scale on the outside of the tube. The plankton thus expeditiously secured can be transferred quickly to a vial or other receptacle, to be weighed or otherwise examined at leisure."

Power may be applied either by hand or through a belt by steam or electric motor.

Our experience with the Planktonokrit indicates :

(1) That two men on each crank cannot get a speed at the receptacle above 3000 revolutions per minute; a rate, however, sufficient to throw out everything except the Cyanophyceæ.

(2) The maximum speed must be continued for at least four minutes.

(3) A speed much above 4000 revolutions with such a large quantity of water is dangerous, with the machine constructed as at present.

This danger may be obviated :

(*a*) By reducing the capacity of the receptacle. (500 cc. is probably sufficient.)

(*b*) By lengthening the bearings of the upright spindle.

(*c*) By enclosing the revolving receptacles in a circular chamber, thus lessening the resistance of the air.

(4) When power was used, more satisfactory results were obtained by arranging the driving pulley so as to cut out the two largest sets of gears. Friction was thereby greatly reduced, and the necessary speed was gained from more rapid revolution of the driving pulley.

(5) It is probable that four receptacles would work more satisfactorily than two.

Some difficulty was experienced in avoiding leaks at the ends of the glass tube. At the distal end the insertion of a closely fitting, vaselined rubber "mushroom" (such as is used when repairing punctures in bicycle tires) was found to answer. Care had to be exercised to keep the entrance to the tube free at the proximal end. To obviate this difficulty it is hoped that a small, heavy annealed glass cone with a ground glass stopper at the apex can be devised in place of the tube.

That the centrifugal method is beyond question the best method of collecting the substances suspended in the water for accurate determination seems to be proved, and great credit is due to Dr. Dolley for his demonstration of the fact.

This method is of value, not alone to him who wishes to determine the proportions of organic matter in drinking water, and to ascertain the quantity of microscopic plants and animals in water from special localities (a very accurate index of its commercial value for fish and shellfish cultivation), but it will enable biologists to study more successfully those lowly forms which lie close to the basis of life, the delicacy of whose structure precludes handling by nets or filters.

It is believed that the perfecting of the centrifugal method for collecting the Plankton will greatly facilitate the practical solution of the increasingly important question of the food supply for man, by ameliorating some of the difficulties which surround the rearing of edible fish in confinement. The eggs can be hatched by millions, but difficulty arises in obtaining a natural or proper food supply. Hence in the case of most species the fry must be liberated very soon after hatching. But every additional day in which they can be kept in confine-

ment increases in a remarkably large ratio the number of these young fish which attain maturity, for the reason that the very young fry are specially liable to destruction from rapacious enemies, storms, etc. With the use of the centrifugal machines for collecting the microscopic food for the young fry, they can be kept longer in confinement, and probably the advantage may be twofold, for in addition to diminishing the mortality, we should expect that growth would be accelerated under the influence of abundant food.

The Rhode Island Agricultural Experiment Station maintains a card catalogue of works upon the subjects connected with Investigations on the Plankton. Printed copies of the Bibliography will be sent upon application. Workers are requested to forward reprints of their papers. Address Biological Division, R. I. Experiment Station, Kingston, R. I.

SOME NEW POINTS IN DINICHTHYID OSTEOLOGY.

C. R. EASTMAN.

THE standard of comparison for all Arthrodiran fishes is the typical genus Coccosteus Agassiz, the osteology of which is known in the minutest detail. As our knowledge of allied genera increases, the more closely do we find them connected by intermediate stages, and the better are we able to trace the sequence of modifications passed through by them. The group of Dinichthyids (*Dinichthyinæ*) is a large one, and contains many bizarre forms, most of which are still very imperfectly known. But when their characters shall have been fully investigated, the wide range of variation manifested by them will be found reducible to order, and the whole promises to constitute one of the most interesting evolutionary series known among fossil fishes.

The characters of Dinichthys have been made out very gradually, through slow, persistent effort, but we are still far from having a complete knowledge of any one species. The only one in which the cranial osteology has been worked out with tolerable accuracy is *D. intermedius*, although the heads of *D. terrelli* and several smaller forms are not uncommon and are not always ill-preserved. Tardiness in acquiring information was inevitable, however, in the case of the Ohio Dinichthyids, owing to their prevailing mode of occurrence in concretions, with attendant obliteration of details. The supply from other localities has been meager, and is preserved in widely scattered institutions. Even where the Ohio material has been concentrated in some of our leading museums, facilities for investigating it have often been lacking. Under such conditions progress has necessarily been slow.

Reference was made in the August number of this journal (p. 556) to the discovery of several well-preserved crania of *Dinichthys pustulosus* from the Hamilton Limestone, which

prove this species to be the most primitive member of the genus known. It is now proposed to illustrate its osteology more fully, and at the same time offer comparisons with other Arthrodires, including Coccosteus and Titanichthys. The two last-named genera, in fact, may be taken to represent the extreme limits of the family *Coccosteidæ*. For in whatever grouping Dinichthys be placed, be it of subfamily rank or otherwise, there is no question that Titanichthys should accompany it; and the relations of Dinichthys to Coccosteus are seen to be so intimate, we are unable to remove it from the same family. On the other hand, the separation of Macropetalichthys and some other Arthrodires from the *Coccosteidæ*, where they are now commonly placed, seems advisable.

Dinichthys pustulosus.

Besides the examples of this species preserved in the Museum of Comparative Zoology, of which the most perfect cranium is from Rock Island, the writer has been able to consult a number of fine specimens belonging to Messrs. Teller, Monroe, and Slocum, of Milwaukee, two from the Cedar Valley Limestone belonging to the State University of Iowa, and one belonging to the United States National Museum, of which last an illustration is given herewith (Fig. 1). The original of this was kindly loaned by Mr. F. A. Lucas, curator in charge of comparative anatomy; the Iowa material by Prof. Samuel Calvin; and the Milwaukee specimens by their owners, to all of whom grateful acknowledgments are hereby rendered.

The larger and more specialized species of Dinichthys and Titanichthys have a nearly flat cranium, and the surface of all the derm plates is smooth, these probably having been covered in life by the integument. The cranium of *D. pustulosus*, on the other hand, is strongly arched from side to side, and, like all the body plates, is covered with innumerable small rounded tubercles, slightly stellate at the base. A narrow band along the sutures, however, is generally striated and destitute of tubercles; and the suture lines themselves are undulatory. In all of these particulars the species bears a

great resemblance to Coccosteus, yet even more striking is the similarity in pattern of the head bones and arrangement of the sensory canals. The transitional characters are so appar-

FIG. 1. — *Dinichthys pustulosus* Eastm. Hamilton Limestone, Milwaukee, Wisconsin. Fragment showing sutures, sensory canals, and finely tuberculated ornament of cranium. Original in U. S. National Museum (Cat. No. 19). Direction of longitudinal axis indicated by the arrow; lettering as in Fig. 2. × ⅞.

ent as to preclude the idea of assigning the two genera to separate families.

An attempt is made in Fig. 2 to represent the cranial shield of *D. pustulosus* as if flattened out, thus facilitating a compari-

son with other diagrams. It is intended at some future time to reproduce a large scale photograph of the Rock Island cranium, on which most of the sutures and sensory canals are visible, in order to show the appearance in perspective of a form so highly arched from side to side as this. The most noteworthy feature regarding the sutures in this species is their prevailing undulatory outlines. No other Dinichthyid has them so sinuous, and even those of Coccosteus are less so in some regions. Beginning with the median occipital element (*MO*), we observe that it is longer and less tapering than in other species of Dinichthys, and is of about the same relative proportions as in Coccosteus. But instead of being slightly sulcated anteriorly, as in *C. canadensis* and some other species, it is deeply lobed, and the anterior boundary is decidedly wavy. Immediately in front of the median and external occipitals lie the paired central elements (*C*), which exhibit almost identical relations with those of Coccosteus. Their anterior and lateral margins are more wavy than in Coccosteus, but their common longitudinal suture is less so. In advance of the centrals are the large preorbital plates (*PrO*), which are separated in front by presumably two median elements, the pineal (*P*) and rostral (*R*). It was impossible, however, to determine the relations of these two plates from any of the specimens that came under the writer's observation, beyond that the pineal seems to be very narrow and without visible perforation. Likewise the boundary between pre- and postorbital plates is indistinct throughout the greater portion of its length ; but it is believed that all of the remaining sutures are accurately delineated in the figure.

One of the most marked points of similarity between *D. pustulosus* and Coccosteus is the fact that the central elements (*C*) are in contact with one another mesially throughout their entire length. These plates are similarly united in Phlyctænaspis, Brachydirus, Homosteus, and Titanichthys, which are sufficient to establish it as a general rule throughout the family *Coccosteidæ*. But an exception would appear to be furnished by *D. intermedius* and *D. terrelli*, provided we can depend upon the descriptions of earlier writers as trustworthy. The

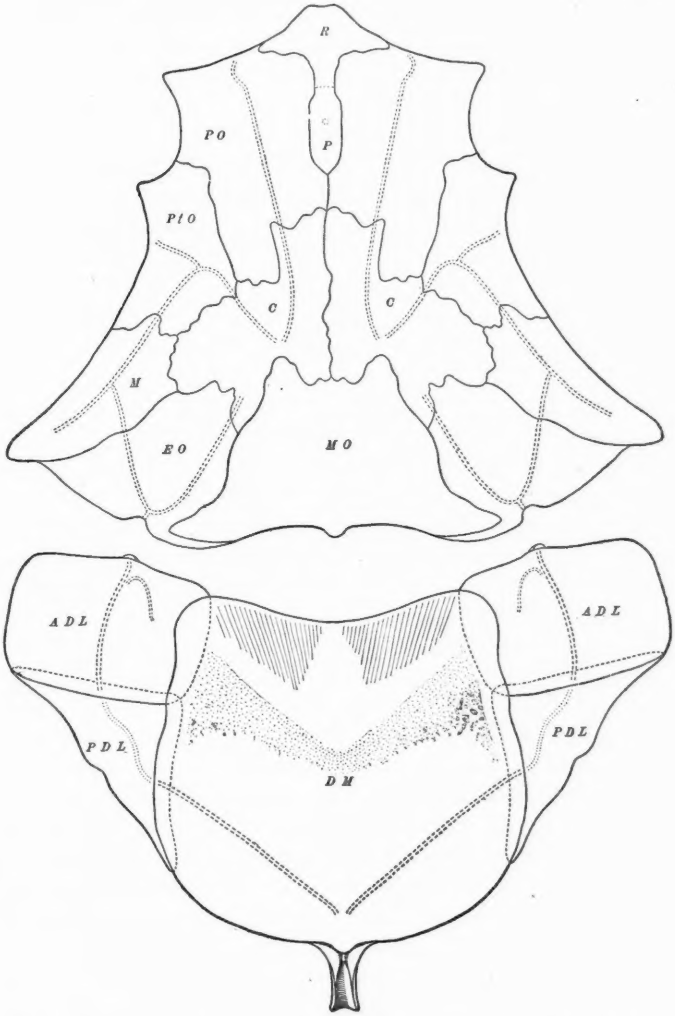


FIG. 2. — *Dinichthys pustulosus* Eastm. Hamilton Limestone, Wisconsin. Diagram showing cranial and dorsal shields. × ¼. *Abbreviations: ADL*, antero-dorso-lateral; *C*, central; *DL*, dorso-lateral; *DM*, dorso-median; *EO*, external occipital; *M*, marginal; *MO*, median occipital; *P*, pineal; *PDL*, postero-dorso-lateral; *PO*, preorbital; *PtO*, post-orbital; *R*, rostral.

restorations of the cranial shield in these species, as given by Newberry, Claypole, and Dean, all show a subdivision of the space corresponding to the centrals in Coccosteus into two paired plates, which are designated as "parietals" and "frontals." Claypole,[1] in describing the skull of *D. intermedius*, speaks as follows regarding the frontal plates: "This area is well outlined in Dr. Newberry's figures, where its boundaries are much more clearly marked than in the specimen now described." And again, in regard to the "parietals" he says: "Judging from the conventional form which he has given to this plate in his restoration, its outlines cannot have been clearly defined in the specimen which Dr. Newberry studied. Instead of the small and elliptical area which he has assigned to it, it has a large size and an irregular outline." We see from this that Newberry's specimen (or specimens) failed to show perfectly the boundaries of one of the subdivisions of the central plate, and Claypole's failed to show the other. It is fair to allow that appearances may have been suggestive of a division in some examples; but the writer can only state from his personal experience that he has not yet been able to observe such a division of the centrals in *D. intermedius* and *D. terrelli*, and is positive that none exists in *D. pustulosus*. We will revert to this matter again under the head of the first-named species.

The arrangement of sensory canals in *D. pustulosus* is very much the same as in other species of this genus, except that they are more curved, especially the preorbital canal, thus recalling the conditions in Coccosteus. In the latter genus, but not in Dinichthys, a lyra is formed in the middle of the shield by the disposition of sensory canals on the central elements. That is to say, the canals following the boundary of the median occipital bend around towards each other, and a transverse channel connects the point of origin of the pre- and postorbital canal systems. A survival of this lyrate arrangement exists in *D. pustulosus*, in that occasionally one or more short, slightly curved, independent canals are seen to

[1] Claypole, E. W. The Head of Dinichthys, *Amer. Geol.*, vol. x (1892), pp. 199–207.

originate below the middle of the central plates and sweep inwards and downwards not far in advance of the median occipital element, sometimes even traversing it for a short distance (Fig. 1). Similar isolated canals occupy the same position in the crania of Titanichthys (Fig. 4), and very often a reminiscence of them appears in *D. terrelli.*

The canals traversing the external occipitals form a Y, whose descending branch passes across the articulating condyle of the antero-dorso-lateral, and thus emerges upon the dorsal system of body plates. In Coccosteus the canal traversing the antero-dorso-lateral bifurcates as soon as it crosses the condyle, a branch running toward either of the posterior angles of the plate, and that running toward the postero-internal angle is continued upon the dorso-median plate. In Dinichthys and Titanichthys there is no such bifurcation on the antero-dorso-lateral, but the canal is single, extending backward along approximately the middle of the plate, and thence on to the postero-dorso-lateral. Nevertheless, in *D. pustulosus* a reversion toward Coccostean conditions is occasionally met with, inasmuch as the antero-dorso-lateral may have a second short canal, ending blindly, as shown in Fig. 2.

None of the American Dinichthyids have heretofore been known to have the dorso-median traversed by sensory canals, although this condition exists in a small European species, described as *D. pelmensis.*[1] But the dorso-median of *D. pustulosus* bears distinct traces of canals, albeit the grooves are narrower and shallower than those of the antero-dorso-lateral plate. They extend obliquely backward from the point where they leave the postero-dorso-lateral and terminate just before reaching the median line of the shield. Only one example of the postero-dorso-lateral has thus far been encountered,[2] and as it lies with its external surface embedded in the matrix, the course of the canal system across this plate (indicated on the diagram by dots instead of dashes) has yet to be verified. Plates that are evenly embedded like this are likely to have

[1] *Bull. Mus. Zool.*, vol. xxxi (1897), Pl. II, Fig. 4.

[2] Now deposited in the Milwaukee Public Museum with the rest of Mr. C. E. Monroe's private collection, of which it forms a part.

their thin edges preserved entire, thus showing the full extent of the overlapped area. We know this condition very well for the element in question, but the same cannot be said for the antero-dorso-lateral, whose thin overlapped edges are invariably broken away in all species. Accordingly, we have had to follow only the broken margin in drawing the outlines of this plate in Figs. 2 and 3, although without doubt the area overlapped by the dorso-median on the one side and clavicular on the other was much greater. The union of the dorso-lateral plates in this species is one of simple overlap, and not by pegs and sockets, as in *D. terrelli* and *D. intermedius.* Here again the resemblance is with Coccosteus.

Through an oversight, the markings on the antero-dorso-lateral, where the overlapping clavicular came in contact with it, were omitted from the diagram, but are essentially as shown in Fig. 3. One example of the clavicular was obtained by Mr. Teller near Milwaukee. It is an extremely heavy plate, bifurcated anteriorly as in other species and tuberculated on its external surface.

Another point of resemblance to Coccosteus is observed in the slight anterior emargination of the dorso-median. The exposed area between this plate and the occiput was very small in comparison with other Dinichthyids. As shown in Fig. 2, the forward part of the dorso-median is quite destitute of tubercles, and the demarcation of the barren area takes place along an oblique line extending from the middle of the shield toward either of the antero-external angles. This we regard as indicative that the anterior portion of the plate was buried beneath the integument. The median keel on the inferior surface is well developed and terminates in a massive posterior process, which attains a length of over 12 cm. in the adult. It depends at a greater angle with the shield than in the larger species, being in fact almost vertical. In this respect it agrees with other primitive tuberculated forms, such as *D. livonicus, D. trautscholdi, D. pelmensis,* and presumably also *D. ringuebergi.* The average length of the shield in the median line, exclusive of process, is about 21 cm. in the adult, and maximum width about 36 cm.

Dinichthys intermedius Newberry.

Fig. 3 shows the arrangement of cranial and dorsal shields in this species, as determined from specimens in the Museum of Comparative Zoology. The diagram of the head is based on a cranium that has already been described with considerable detail by Claypole,[1] and his figure was copied with slight modifications in a former paper by the writer.[2] The present figure does not differ materially from either of the preceding ones, except that the boundaries of a few plates are slightly altered, the position of the pineal foramen is indicated, and the suborbital and opercular ("postmaxillary" Newberry), which do not properly form a part of the head shield, are here omitted. A supernumerary sensory canal, thought by Claypole to extend along the boundary between the pre- and postorbital plates near the orbits is also suppressed, as nothing but the suture was observed in this region. The pineal plate has been shortened somewhat, but its outline is still conventionalized after Claypole's figure, the element itself being missing from the specimen. In *D. terrelli* and *D. pustulosus* this plate is relatively shorter and narrower than here represented, but owing to its tenuity, is seldom well preserved.

As already remarked, the writer has not been able personally to observe a division of the central element into two plates, termed by Newberry, Claypole, and others the "parietal" and "frontal." The boundary, as depicted by Claypole, has been allowed to stand in dotted lines on the present figure, but the two portions occupying the space of the central are designated C^1 and C^2, instead of by the misleading terms commonly applied to them. If two plates could actually be shown to exist here, the terms *central* and *precentral* would be decidedly more fitting. It is true that in Phlyctænaspis a division of the marginal into two separate elements, angular and marginal proper, has been noticed by Traquair;[3] and unless von Koenen[4] has mistaken the initial portion of the preorbital canal for a suture, a similar

[1] *Loc. cit.* (1892), pp. 199–207.
[2] *Bull. Mus. Comp. Zool.*, vol. xxxi (1897), Pl. I, Fig. 1.
[3] *Ann. Mag. Nat. Hist.* [6], vol. xiv (1894), p. 369.
[4] *Abhandl. Akad. Wissensch. Göttingen*, Bd. xl (1895), Taf. II, Fig. 6.

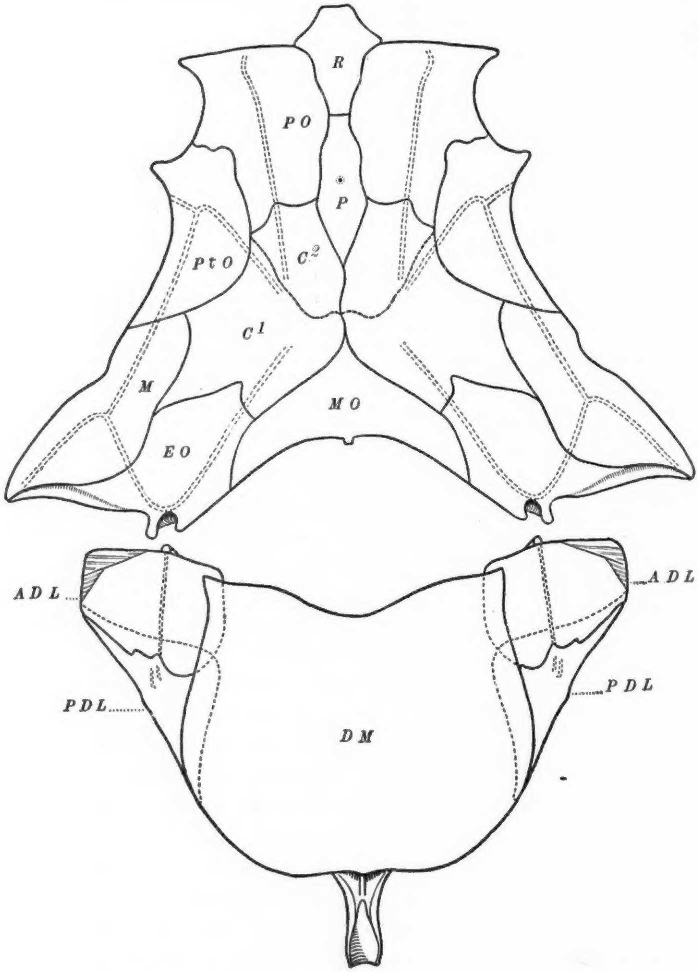


FIG. 3. — *Dinichthys intermedius* Newb. Cleveland Shale, Lorain County, Ohio. Diagram showing cranial and dorsal shields. × ¼. Lettering as in Fig. 2.

division of the central element of Brachydirus into two plates is to be inferred. But owing to the poorly preserved condition of von Koenen's material, a confusion of sensory canals and sutures was easily possible; and a comparison of the remaining

figures, given by this author, leads us to believe that the central was in reality undivided in Brachydirus; that is to say, its relations are the same as in Coccosteus and *D. pustulosus*.

There is a chance, therefore, that the recognition of a pre-central plate in Dinichthys depends upon faulty observation, and we are strongly of the opinion that no *bona-fide* sutures were ever seen on the dorsal surface cutting off a portion of the central, as earlier writers would have us believe. But on examining the visceral surface of the head shield, one can easily understand how the solidifying crescentic ridge (seen one on either side of the median line and abutting against the equally heavy ridge of the median occipital), which stands in marked contrast to the thin forward extension of the central, might give one the impression of a distinct element.[1] The function of these ridges is to strengthen the base of the skull, and it would be strange, indeed, if they were cut through by sutures visible from below, where such are generally more obliterated than on the dorsal surface, and yet are not apparent from above. It is true that the ridges rise very abruptly, but although their separation from the central plate proper may seem to be indicated by some specimens, owing to difference in texture of bone substance, we regard it as very improbable that a suture exists here. Inasmuch as the central is a single element in *D. pustulosus*, it would certainly be anomalous not to find it entire in all species of this genus.

The median occipital element of *D. intermedius* is acutely pointed in front, with the apex extending forward between the centrals, as in Phlyctænaspis and Brachydirus, but this is an exception to the general rule in Dinichthys and Titanichthys. The anterior margin of the median occipital in *D. terrelli* resembles that of *D. pustulosus*, except that the indentations are shallower. Both *D. intermedius* and *D. terrelli* have the nuchal margin strengthened below by a heavy ridge which extends from the median line obliquely outward and backward on either side as far as the sockets of the exoccipital plates. In *D. pustulosus* the ridges on the under surface of the occipital

[1] *Cf.* Newberry, J. S. Palæozoic Fishes of North America, *Monogr. U. S. Geol. Surv.*, vol. xvi (1889), Pl. LII, Fig. 1.

and central elements are not nearly so heavy as in other species of Dinichthys, and the formation of the double socket in the middle of the nuchal line is simpler. This peculiar structure is supposed by Claypole to mark "the place of insertion of some powerful muscle or ligament that connected the head with the rest of the body." It is well shown in a number of Newberry's figures of Dinichthys and Titanichthys.[1] The bone is extremely dense in this region, and the thickness of the cranium is greater than in any other place. Hence, fragments that have been rolled about or subjected to weathering often become reduced so as to leave nothing but this portion of the occiput.

Dinichthys terrelli Newberry.

This species is numerically the most abundant of American Dinichthyids, and the largest collection of its remains is preserved in Columbia University.[2] The writer, having but one head at his disposal in the Agassiz Museum, has not essayed to figure the cranial osteology, but we may say it does not differ materially from that of *D. intermedius.* The Cambridge specimen shows no evidence of a division of the central into two parts, but the solidifying ridges on the under surface are detached from the cranial bones for a slight distance anteriorly, thus producing the semblance of separate plates.

[1] *Loc. cit.* (1889), Pl. I, Fig. 2; Pl. IV, Fig. 2; Pl. VIII, Fig. 4; Pl. LII, Fig. 1.

[2] Since this article was written the writer has enjoyed the privilege, thanks to the courtesy of his friend Dr. Bashford Dean, of looking over the greater part of Professor Newberry's collection, which has recently been stored in cases in Schemerhorn Hall. No specimens could be found to prove the existence of "parietal" and "frontal" elements, and the conclusion is that they do not occur. A large example of the antero-dorso-lateral with entire margins (embedded in shale) proves that this plate extended underneath the dorso-median and clavicular elements for a distance hitherto unsuspected, the covered area being even greater than the exposed. Newberry's figures of the clavicular in this species are seen to be based upon an imperfect specimen, the superior margin of which has been artificially restored, and is to a certain extent misleading. On the other hand, the collection contains some unusually perfect examples of this plate, which certainly deserve to be figured. There is also abundant evidence to show that the normal condition of the ventro-median plates in *D. terrelli* was one of simple overlap, but, in the adult stage, fusion of the two elements may progressively set in.

The relations of the dorso-lateral plates have been sufficiently treated in former papers, in one of which the writer lamented the fact that no plates corresponding to the laterals of Coccosteus have as yet been brought to light. It seems really quite remarkable that the plate which students of Dinichthyid anatomy have been looking for so long, and has heretofore been regarded as missing, should finally turn out to be one we are all familiar with, and has simply been masquerading under another name these many years. We refer to the "*clavicular*," so named because it was supposed to have formed part of the shoulder girdle. Different writers have made various guesses as to its position on the body. Newberry[1] turned it end for end, its bifurcations being supposed by him to have embraced the antero-dorso-lateral. Claypole[2] considers — "that it was external and ventral can hardly be doubted," — and also confuses rights and lefts. Dean[3] pictures it in his frontispiece as standing vertically and supporting the mandibles.

According to our interpretation, the plate in question has nothing to do with a shoulder girdle, and there is absolutely no evidence that the Dinichthyids possessed paired appendages. The clavicular is in the form of a carpenter's square, roughly speaking ; one arm is bifurcated and extends anteriorly and outwardly, the other is single, broad, and flat, and is directed nearly at right angles with the longitudinal axis of the body. The broad arm is homologous with the *anterior lateral* of Coccosteus, and occupies a corresponding position. The heavy ridge on its under side fits into a depression running along the front margin of the antero-dorso-lateral, and its flat expansion overlies a large area of the latter plate, as shown by characteristic markings (see Fig. 3). The same arm also extends across the interval between cranial and dorsal shields, overriding a rounded flange at the base of the external occipital. The sensory canal running down to the posterior apex of the marginal plate is continued on to the clavicular, being traceable along the margin of the transverse arm as far as the right

[1] *Loc. cit.* (1889), p. 142.
[2] *Rep. Geol. Surv. Ohio,* vol. vii (1893), p. 110.
[3] *Fishes, Living and Fossil.* New York. 1895.

angle. Fitting in behind this arm and abutting against the postero-dorso-lateral, as shown by impressions on both, was the *posterior lateral,* a plate not hitherto identified as such. It may be that Newberry's supposed "hyoid (?)" plate[1] occupied this space, but further comparisons are necessary to establish the truth of this inference.

The side plates of the body being now fully accounted for, it may be asked why the name anterior lateral is not substituted instead of "clavicular." The answer is that only one arm of this plate corresponds to the anterior lateral of Coccosteus, while the bifurcated arm represents something entirely different. Hence we must either go on calling the whole structure clavicular, or invent a new name for it; we prefer the former course, although technically the term is a misnomer. It will require a separate article to illustrate the relations of the bifurcated arm, and we will pass over this for the present, remarking only that the inner branch consists of a long thin blade which is probably homologous with the *interlateral* of Coccosteus, and the external curved branch has articulated to it distally a peculiar warped plate, supposed to have formed part of the modified branchiostegal apparatus.

The effect of this orientation of the clavicular is to revolutionize previous notions as to the form of cross-section in Dinichthys and Titanichthys. Instead of being deep-bodied creatures, it is now plain that the more specialized species, with their flat dorsal and abdominal shields and excessively wide cranium, must have had almost ray-like proportions, and this depression of body was no doubt correlated with bottom-feeding. We observe also, which was not suspected before, that the plastron was not in contact with other dermal plates, and covered a relatively small portion of the abdomen. The flat portion of the suborbital probably had a continuous slope with the head shield, its inclination (and also that of the clavicular) being more nearly horizontal than vertical. These relations can best be shown in a side-view restoration, which we hope to present at a subsequent time.

The only writer to attribute an opercular plate to Dinichthys

[1] *Loc. cit.* (1889), Pl. V, Fig. 3.

is Professor Newberry, who figures it (under the designation of "postmaxillary") in his restoration of *D. intermedius*[1] as if suturally united with the suborbital. We have never observed traces on the suborbital indicating a connection with a posterior element, and as its flat expansion reaches in *D. terrelli* almost as far as the posterior angle of the head shield, the opercular either did not occur in this species, or is represented by the hinder part of the suborbital's expansion. *D. intermedius*, however, had a relatively shorter suborbital than the larger species, and theoretically it ought to be followed by a separate plate. Newberry's supposed "eye capsules,"[2] which are preserved in a fairly constant position on the visceral side of the skull, we interpret as *nasal* capsules.

Titanichthys agassizii Newberry.

The cranium upon which this species is founded is unique, and forms one of the principal treasures of the Museum of Comparative Zoology. The mandibles belonging to it, however, are preserved in the Museum of Columbia University, together with all the specimens of *T. clarkii* that have been collected up to within the last few years.

Newberry describes the head of Titanichthys as being "triangular in outline, over four feet broad at the occiput, the nasal portion imperfect in all the specimens known, and the surface smooth or granular, marked by incised lines which form a pattern indistinctly shown in the specimens yet examined." He made no attempt to describe the osteology in either of his species, and the head of *T. clarkii* was not even figured. The "incised lines" (sensory canals) are shown after a fashion in his representation of *T. agassizii*,[3] and their arrangement is still more imperfectly shown in the rough diagrams given by Cope[4] of the same species. As a matter of fact, the sensory canal system is indicated with tolerable clearness on the

[1] *Loc. cit.* (1889), Pl. LII, Fig. 2.

[2] *Ibid.*, Pl. VII, Fig. 2.

[3] *Ibid.*, Pl. I, Fig. 1.

[4] On the Characters of Some Palæozoic Fishes, *Proc. U. S. Nat. Museum*, vol. xiv (1891), Pl. XXXI, Fig. 6.

original head of *T. agassizii*, and enough of the sutures are traceable to give a pretty fair idea of the arrangement of cranial plates. The boundaries of the latter are represented in the accompanying diagram (Fig. 4) by continuous lines as far as they can be made out with certainty, and are dotted in where more or less obscure. Sensory canals are indicated by the usual convention of double dotted lines. The posterior and lateral margins of the skull are entire; the part broken away includes a portion of the preorbitals and pineal and the whole of the rostral (or "ethmoid") plate. It is very evident, however, that the head was more elongated from side to side than in an antero-posterior direction, which is opposite to the usual rule. It is also almost perfectly flat, instead of being transversely arched.

In consequence of the huge size of the head and thinness of the plates, rigidity could only be attained by a nearly complete fusion of the cranial elements, and this rendered the artifice of dovetailing unnecessary. Nevertheless a vestige of the usual interlocking condition remains in the anterior boundary of the central element, where there are a few moderate-sized undulations. Presumably the centrals met each other in the middle along a wavy line, as mechanical principles would seem to require, but the suture itself is now almost wholly obliterated. There is likewise no sort of indication that the space homologous with the central was divided into two components. The pineal plate seems to have been of elliptical outline and longest in a transverse direction. It is extremely attenuated at its lateral edges, where it has been somewhat broken away. Here and along the antero-external margins of the central were the thinnest regions of the cranium, the bone being considerably less than .5 cm. through. The pineal foramen is enclosed in an elliptical capsule of very dense tissue, and opens on the dorsal surface in a circular orifice. An interesting fragment in the collection of Dr. William Clark, of Berea, Ohio, shows that this opening was covered by a thin opercular plate lying loose on the upper surface and undoubtedly movable in life. In another specimen the foramen is seen to be double, the two being separated a slight distance sidewise.

The rostral plate, termed also "nasal" and "ethmoid" by different authors, has been entirely broken away from the type specimen, together with the forward portions of the preorbital plates. The margin of the latter extends for such a distance inwardly in advance of the orbits as to suggest that the head

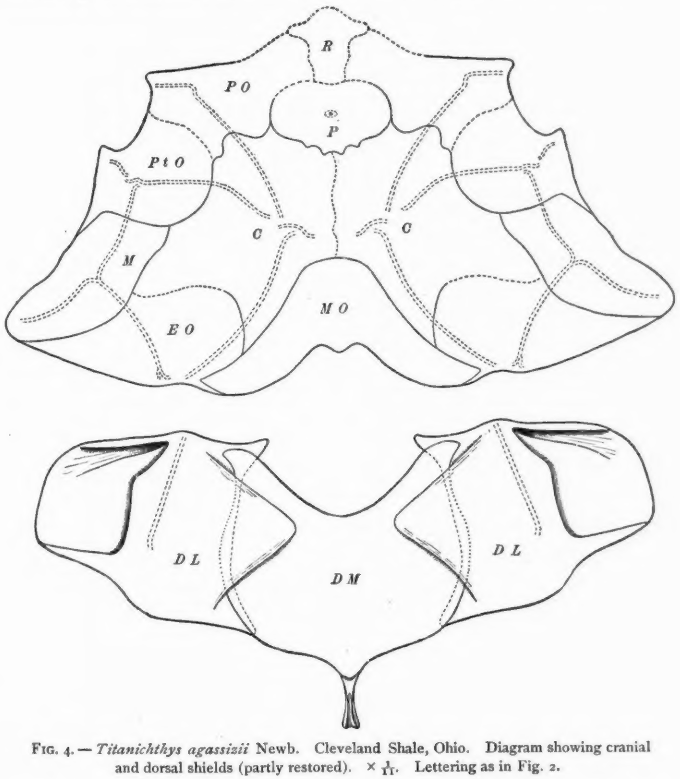


FIG. 4.— *Titanichthys agassizii* Newb. Cleveland Shale, Ohio. Diagram showing cranial and dorsal shields (partly restored). × $\frac{1}{11}$. Lettering as in Fig. 2.

was foreshortened in the manner shown by the diagram. It is possible, of course, that both rostral and pineal plates were transversely elliptical, instead of the pineal only, as here represented; but in either case the effect on the preorbitals was to give them a very different aspect from the usual condition in the *Coccosteidæ*. These three plates are the only ones which differ markedly from their homologues in Dinichthys.

Newberry's figures show the formation of the nuchal sockets on the under surface of the occiput very clearly. They are quite deep and divided by a thin longitudinal septum, but are not bounded below by a transverse septum, as in *D. terrelli.* The thickness and compact texture of the bone substance in this region are very remarkable, as noted above. The nuchal ridges are broad and massive, but not nearly so prominent as in Dinichthys; and the median longitudinal ridges, together with those belonging to the central ("parietals"), which are so conspicuous in *D. terrelli* and *D. intermedius*, are here altogether lacking.

The arrangement of sensory canals is sufficiently indicated by the diagram, and the articulation of cranial and dorsal shields is so familiar from Newberry's writings that we may pass over these topics. We cannot agree with the latter author, however, that the hinge joint permitted a lateral as well as vertical motion of the head shield, and even the vertical motion must have been restricted in large measure by the overlapping claviculars.

The outline of the dorso-median is reduced from a photograph purporting to be of *T. clarkii*, but, as will be shown presently, there are good reasons for believing it to belong to this species. Not only does it overlap the inner edges of the dorso-lateral plates (for a distance not determinable from the specimen at hand, but probably greater than shown in Fig. 4), but it in turn passes underneath a heavy flange which is given off from the superior surface of the dorso-laterals. The edges of the dorso-median are thus received into a deep groove formed by the side plates; and in another species, as we shall see, the articulation was still further complicated. How far the flange extended backward over the surface of the dorso-median cannot be told with certainty, as it is broken off in the manner shown by Newberry's illustrations.

The term *dorso-lateral* is here used to include the mass of bone contiguous to either side of the dorso-median, the components of which are apparently fused. That two elements are concerned in the formation of this apron-like expanse is patent from a number of features, such as the arrangement of

vascular canals, tenuity of bone substance along the presumable line of fusion, and nature of the free margin corresponding to the postero-dorso-lateral on the right-hand side of the specimen; but no distinct evidence of a suture line is to be observed. It will be remembered that Macropetalichthys also affords an instance of fused dorso-laterals.[1] On the diagrams given herewith all exposed or overlapping margins are shown by continuous lines, and underlapping margins by dotted lines; round dots are used where the dorso-median passes under the flange of the dorso-laterals, and dashes along the overlapped inner margins of the latter plates.

In the region of articulation with the head shield the dorso-laterals are extraordinarily heavy. The thickness even exceeds that of the occiput, being between 5 and 6 cm. through. Great rigidity, however, was necessary in order to hold the claviculars firmly in place. The latter were of huge proportions, but composed of a relatively thin shell of bone. A large area of the dorso-lateral was overlapped by the clavicular, as indicated by shading in Fig. 4, and the heavy ridge on the visceral surface of the latter plate was received into a corresponding deep depression along the anterior margin of the dorso-laterals. Very excellent examples of the clavicular, belonging probably to the next species, are to be seen in the Columbia and Oberlin Museums.

Titanichthys clarkii Newberry.

The dorso-median shown in Fig. 5 is reduced from one of Newberry's illustrations,[2] the original of which the writer has failed to see, although it is said to be still preserved in the Museum of Columbia University. It has not been previously recognized as a dorso-median, Newberry having figured it in an inverted position and referred it to the "under side of the body or head." The dorsal aspect is here represented, and we suspect that the visceral side was embedded in the matrix, since otherwise Newberry could not have failed to observe the

[1] *Amer. Nat.*, vol. xxxi (1897), p. 497.
[2] *Loc. cit.* (1889), Pl. III, Fig. 1, described on p. 135.

median carina. Its slender terminal process must also have been broken off before he saw the specimen.

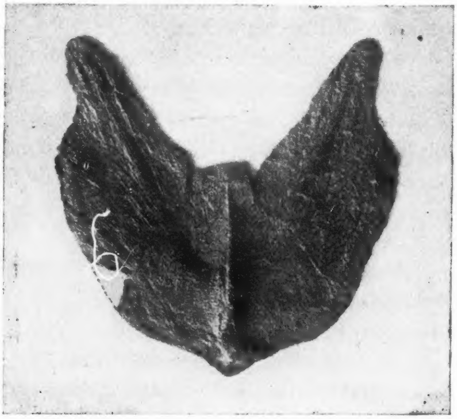


FIG. 5. — *Titanichthys clakrii* Newb. Cleveland Shale, Ohio. Dorso-median plate lacking median anterior spine and cranial process. (Reduced from a figure by Newberry.) $\times \frac{1}{21}$.

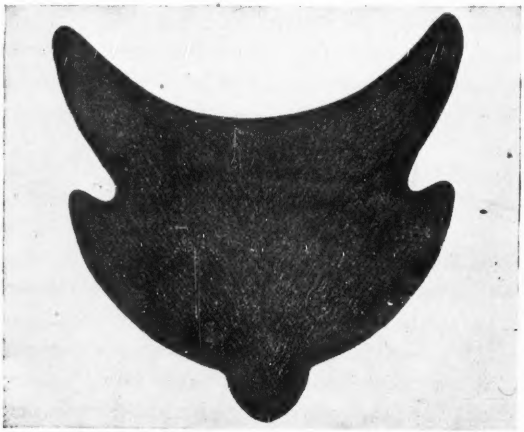


FIG. 6. — *Titanichthys* (?) sp. Cleveland Shale, Lorain County, Ohio. Visceral aspect of dorso-median belonging presumably to an immature individual. Original in Oberlin Museum. Very nearly natural size.

The chief peculiarity of this plate is the deep indentation of its lateral margins, but this is to be regarded merely as a

specialization of the lobes occurring in the same region among other species, such as *D. ringuebergi*[1] for example, and also in the plate shown in Fig. 6. We may be sure that it had to do with the mode of articulation with the dorso-laterals, perhaps serving for the reception of a ridge given off from the latter. It would naturally be supposed from the figure that the anterior margin was entire, but we cannot avoid a suspicion that a sharply pointed projection in the median line has been broken off, since a similar fragment with associated bones on exhibition at Columbia shows such an anterior projection. Trachosteus, too, has the dorso-median cuspidate in front, but the plate is reduced in size to a mere caricature. Even the small dorso-median shown in Fig. 6, the original of which is preserved in the Oberlin College Museum, shows a broken extension in the median line anteriorly, which may originally have been pointed or triangular. We have reproduced a photograph of this shield, kindly furnished by Prof. A. A. Wright, for the sake of comparison with Fig. 5, as there are several points of mutual resemblance. In fact, the stamp of Titanichthys is so strongly impressed that we must regard the plate either as belonging to an embryonic individual of this genus, or else as representing a pygmy species essentially similar to the Titans. It has a strong anterior emargination, slender antero-external angles, and a relatively large posterior expansion of the dorsal surface, all of which characters are possessed in common with Titanichthys rather than with Dinichthys. Moreover, the antero-lateral margins are deeply lobed, and without question these sinuses are of corresponding nature with the incisions already noted in the dorso-median of *T. clarkii*. It will be understood that the carinal process has been broken away from both specimens, its point of attachment being just underneath the conspicuous posterior expansion of the shield.

Having now identified Newberry's "hyoid (?) or ventral plate" of *T. clarkii* as the dorso-median properly belonging to that species, the question arises, where is the shield to be placed which this author referred to *T. clarkii?* We can only answer, without having seen the specimen, that there is a strong

[1] *Amer. Journ. Sci.* [3], vol. xxvii (1884), p. 477, Fig. 1.

presumption of its having belonged to *T. agassizii.* For we have already noticed that the shield in the latter species is without deep lateral incisions and has no triangular projection in front; and moreover its form (see Fig. 4) agrees with Newberry's statement that "the dorso-median shield is rounded in outline, about two feet in diameter, much thinner than that of Dinichthys, and with a long and relatively slender process, which reaches backward and downward apparently to gain the support of the neural spines."[1] The large size of this particular specimen is, however, remarkable.

[1] *Loc. cit.* (1889), p. 130.

THE WINGS OF INSECTS.

J. H. COMSTOCK AND J. G. NEEDHAM.

CHAPTER IV.

The Specialization of Wings by Addition.

I. THE DEVELOPMENT OF ACCESSORY VEINS.

THE more important of the generalizations reached in the course of the present investigation are two in number; first, the recognition of certain features of the venation of the wings of insects, which occur in the more generalized forms of a large proportion of the orders of this class, has enabled us to present a hypothetical type to which the wings of all orders may be referred;[1] second, if we leave out of consideration the anal area, that portion of the wing traversed by the anal veins, we will find that in nearly every case each order of insects is characterized by either a reduction or a multiplication of the wing-veins; in certain orders the tendency is in one direction, while in others it is in the opposite; but either of these tendencies may be correlated with a similar tendency in the anal area or with the opposite one.

In the preceding chapter we pointed out the various ways in which the number of the wing-veins in the preanal area is reduced. In nearly every case we found the reduction of the preanal area accompanied by a similar tendency in the anal area, or, if a reduction had not taken place, there was no increase in the number of veins of this area, the tendency being towards the production of a few-veined wing. The Trichoptera, however, form an exception to this rule.

We have now to consider several types of wings, in each of which there is taking place an increase in the number of veins of the preanal area, the tendency being towards the formation of a many-veined wing. In speaking of an increase in the number of veins, reference is made only to a multiplication

[1] *American Naturalist*, vol. xxxii (February, 1898), pp. 81–89.

of the branches of the principal veins. In no case is there an increase in the number of principal veins. And this increase in the number of branches may be confined to one or two of the principal veins, while the number of the branches of some of the other veins may be reduced, the expanding of some parts of the preanal area resulting in a crowding of other parts. In some cases we will find that the multiplication of wing-veins extends to the anal area also ; in others we will find the anal area greatly reduced. But even in those cases where the anal area is reduced, the total result has been the production of a many-veined wing.

In the many-veined wings both the longitudinal veins and the cross-veins are increased in number. In most cases where there are many cross-veins it is impracticable to distinguish from others those particular cross-veins to which we applied special names in describing the few-veined wings.[1] But in the case of the longitudinal veins it is necessary to distinguish the primitive veins, that is, those of our hypothetical type, from the veins that have been developed in addition to these. For if this is not done it will be impossible to point out the changes that have taken place in the course of the development of each of the various types of many-veined wings. We therefore apply the term accessory veins to these secondarily developed longitudinal veins, and retain the same nomenclature for the primitive veins that we used in describing the few-veined wings.

Accessory veins may be borne by any of the primitive longitudinal veins ; and they may arise from either of the two sides of such a vein. In most cases it is unnecessary to designate the individual accessory veins, as, usually, it will be sufficient for descriptive purposes to indicate the number of these veins that have been developed upon a particular longitudinal vein. In fact, in certain cases more than this could not well be done owing to the irregularity of the veins. On the other hand, in many cases the accessory veins borne by a single primitive vein present a high degree of regularity, and it is evident that they have been developed in a regular sequence. Under these

[1] *American Naturalist*, vol. xxxii (April, 1898), pp. 233, 234.

circumstances it is practicable to designate them individually; and we have devised the following method for this purpose.

The accessory veins arising from one side of a single primitive vein are considered as a single set, and to each set of veins a distinct set of numbers is applied, beginning with the oldest (*i.e.*, the first-developed) member of the set.

By this method homologous veins, when a homology exists, will bear the same number. But it should be remembered that as accessory veins have arisen independently in many different groups of insects, it often happens that accessory veins similar in position, and bearing the same number in our system, are merely analogous and not homologous.

In order to apply this system it is necessary to know, in the case of each group of insects studied, the sequence in which the members of the particular set of veins under consideration have been developed. For additions to such a set of veins may be made to the distal end of the series, or to the proximal end, or may be interpolated at some distance from either end.

Frequently an examination of the wing of an adult insect is sufficient to determine this sequence. But the determination can be made in a much more satisfactory manner by a study of the tracheation of the wings of the nymph or pupa. For in the many-veined insects the longitudinal veins, both primitive and accessory, are developed about tracheæ; and it is much easier to determine the homologies of the tracheæ of an immature wing than it is to determine the homologies of the wing-veins of the adult. And, too, in this way we are able to eliminate the cross-veins which are not preceded by tracheæ in the forms used for illustration here. We will, therefore, use for this purpose the wings of immature insects.

Accessory veins added distally. — If the radial tracheæ of the pupa of Chauliodes (Fig. 53) and of the pupa of *Corydalis cornuta* (Fig. 54) be examined, it will be seen that both differ from our hypothetical type in the presence of a greater number of branches of the radial sector. And a comparison of the two figures shows that the increase in the case of Corydalis has been greater than in the case of Chauliodes. Farther, the presence of fine twigs at the tip of the trachea R_s indicates the

method of increase, which is doubtless as follows : the branches have been added one after another to the tip of trachea R_2, there being a migration of the base of each accessory trachea towards the base of the wing, thus making room for the addition of new branches. In this case the first accessory vein is the proximal one.

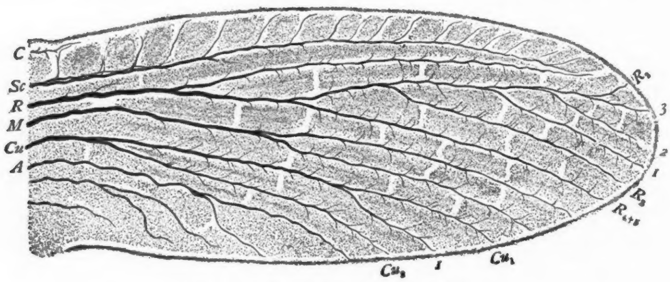


FIG. 53. — Wing of a pupa of Chauliodes.

In Sialis (Fig. 55) the accessory veins have been developed in a similar way, but they are on vein R_3 and on the cephalic side of this vein. Here, too, the first accessory vein is the proximal one. But it should be noted that the numbers of the veins increase in the opposite direction from what they do when the accessory veins are added distally on the caudal side of a primitive vein, as in the radial sector of Chauliodes and Corydalis.

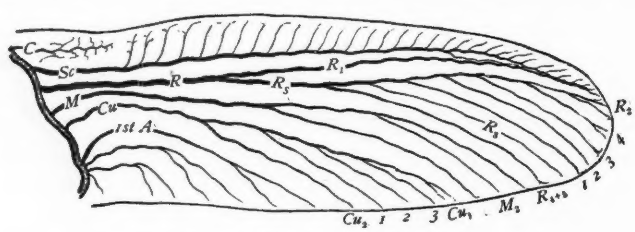


FIG. 54. — Wing of a pupa of Corydalis.

Accessory veins added proximally. — A good illustration of the adding of accessory veins to the proximal end of a series is afforded by the accessories of vein Cu_1 in the Blattidæ. Fig. 56 represents the hind wing of a nymph of a cockroach. An

examination of the set of accessory veins borne by vein Cu_1 shows that the distal members of the series are well developed, and that the growth of additional veins is taking place in the disk of the wing at the proximal end of the series. In this case the first accessory vein is the distal one.

Accessory veins interpolated. — In the wing of the cockroach

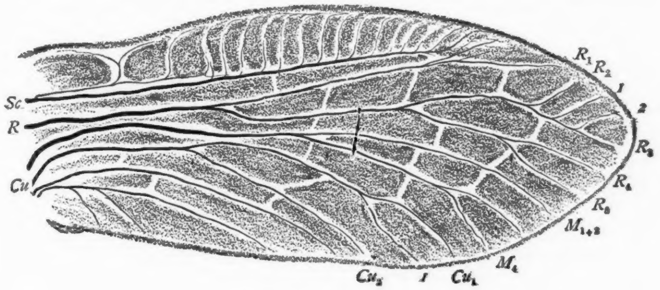


FIG. 55. — Wing of a pupa of Sialis.

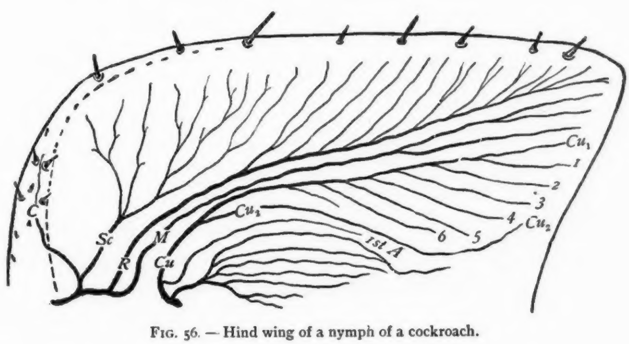


FIG. 56. — Hind wing of a nymph of a cockroach.

represented by Fig. 56 there are many accessory veins borne on the cephalic side of radius. From the presence of the fine twigs near the apex of the wing, it is evident that accessory veins are being added distally. It is also evident that the number of veins is being increased by the splitting of certain of the older veins, *i.e.*, by interpolation. In cases of this kind it is impracticable to number the members of a series of accessory veins.

II. THE SUPPRESSION OF THE DICHOTOMOUS BRANCHING OF VEINS.

In the more highly specialized of the many-veined insect wings there exists a type of branching which is very different from that of our hypothetical primitive type. An examination of Fig. 57, which represents this type, will show that in every case the forked veins are branched dichotomously, while in the many-veined wings the more characteristic type of branching results in the formation of pectinate veins; this pectinate type of branching is well shown by the radial sector of Corydalis (Fig. 54).

The prevalence of the pectinate type of branching in the many-veined wings has been, doubtless, the greatest obstacle

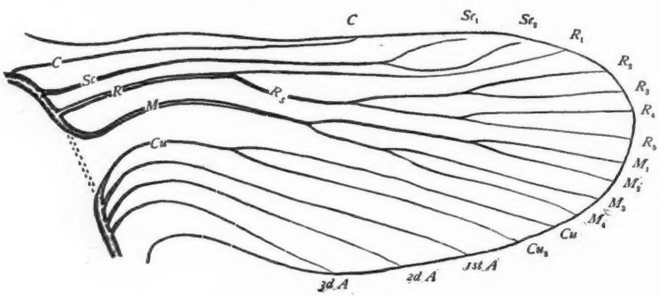


FIG. 57. — Hypothetical type.

to a recognition of the homologies of the branches of the forked veins in such wings. Our hypothetical type was first worked out by a study of the few-veined wings; but it was a long time after that was accomplished before we saw that the pectinate type of branching had been derived from the same type. The most potent factor in reaching this conclusion was the fact that in some of the many-veined insects the dichotomous type of branching has been preserved. Good illustrations of this can be seen in the neuropterous genus Sialis (Fig. 55), while equally good examples of the pectinate type are presented by the closely allied genera Chauliodes and Corydalis (Figs. 53, 54).

The changes that take place in the development of the pectinate type of venation from the dichotomous type are of two

kinds: first, the development of accessory veins; second, the modification of the primitive veins so that they are no longer dichotomously branched. The former has been discussed above; we will now briefly refer to the latter. For this purpose we will give a series of diagrams illustrating several types of branching of the radial sector.

Fig. 58*a* represents the typical or dichotomously branched radial sector. Fig. 58*b* represents a typical radial sector with the addition of some accessory veins on the caudal side of vein R_2. Such a radial sector occurs in the fore wing of Ithone.[1] In this case the radial sector is nearly pectinate, but not quite so, owing to the forked condition of vein R_{4+5}. In Chauliodes (Figs. 53, 58*c*) veins R_4 and R_5 coalesce to the margin of the wing; and in this way the pectinate type is attained. In Hemerobius (Figs. 58*d*, 59) the pectinate type has been attained by fission instead of coalescence. Here veins R_4 and R_5 have split apart till vein R_5 arises from the main stem of radius.

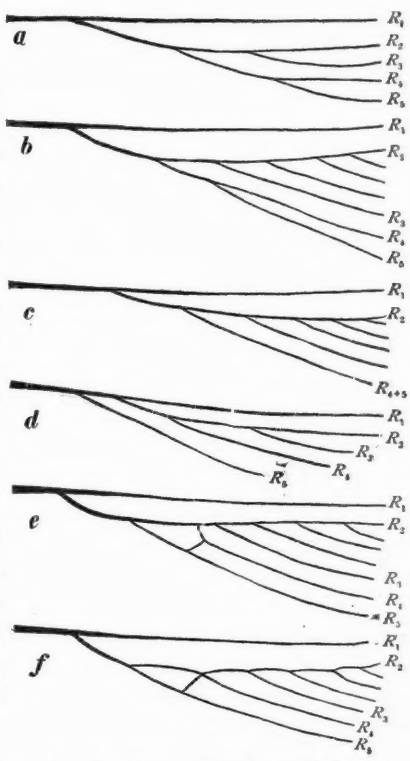


FIG. 58. — Diagrams of several types of radius.

When many cross-veins are present, the dichotomy of the branching of the sector may be suppressed in still another way, by the transference of the base of vein R_4 to

[1] Brongniart. *Rech. sur l'Hist. d. Insectes Fossiles*, Pl. I, Fig. 10.

vein R_{2+3}. All stages of this switching of vein R_4 occur in the Myrmeleonidæ; but two examples will suffice to illustrate it. In Myrmeleon (Fig. 58*e*) the base of vein R_4 appears to be forked; one arm of the fork arising from vein R_5, the other from vein R_{2+3}. The former is the true base of vein R_4; the latter is a cross-vein which is assuming the function of a base of this vein. In the hind wing of *Ptynx appendiculatus* (Fig. 58*f*) the switching has been completed, vein R_4 arising from vein R_{2+3}.

In the foregoing illustrations comparisons of allied insects have been made in order to determine the ways in which the wings are being modified; frequently a comparative study of the fore and hind wings of a single insect is equally suggest-

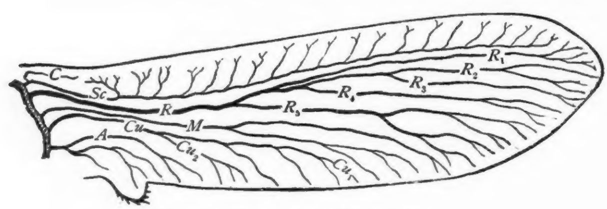


FIG. 59. — Wing of a pupa of Hemerobius.

ive, for it often happens that the two pairs of wings exhibit different degrees of the same kind of modification, and thus the course of the change is indicated.

A study of the causes of the changes which we are describing is beyond our present purpose, which is merely to determine the homologies of the wing-veins. But we can gain a hint of the probable reason for the development of the pectinate type of veins without entering very deeply into questions of the mechanics of flight.

It is obvious that many styles of flight exist among insects, and that for the different styles of flight different kinds of wings are required. In Corydalis (Fig. 54) the wing is stiffened, along a line parallel with the costal margin of the wing, by the subcosta, the main stem of the radius, and veins R_1 and R_2. Back of this line there is a broad, flexible area, which bends up during the downward stroke of the wing, forming an inclined plane, the pressure of which against the air forces the

insect ahead. The flexibility of this area of the wing is increased by those changes which result in the formation of the pectinate type of branching.

The extreme of the pectinate type of branching exists in the neuropterous genus Polystœchotes, in which the area traversed by the parallel veins is very broad.

NOTE ON THE VARIATIONS IN THE TELEUTO-SPORES OF PUCCINIA WINDSORIÆ.

JOSEPH ALLEN WARREN.

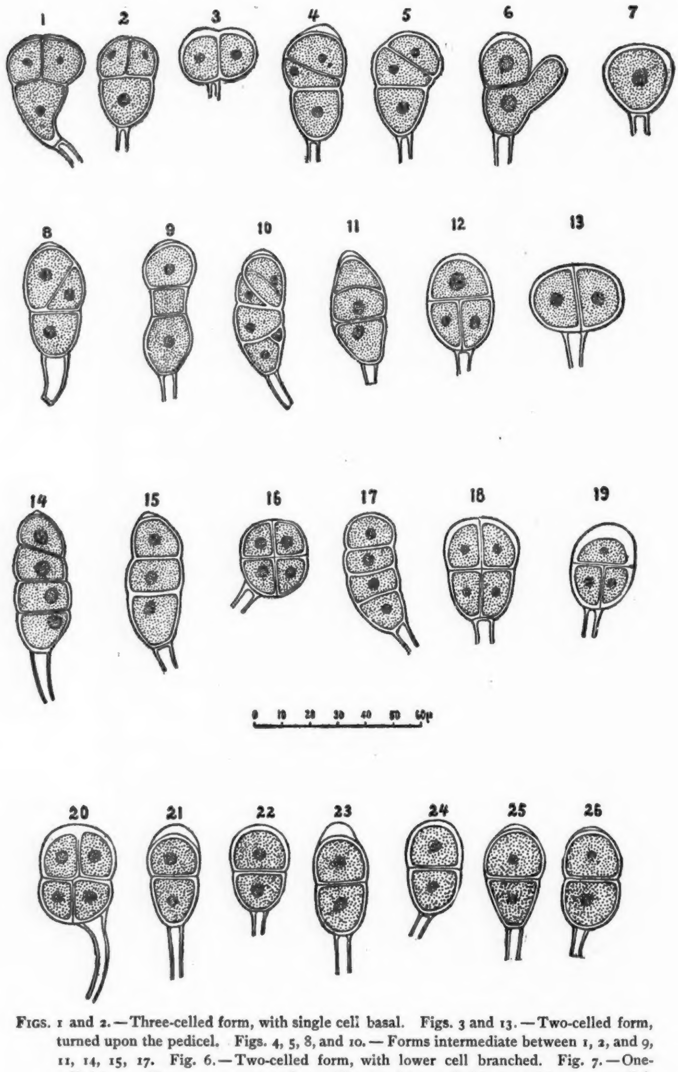
EVERY one who has studied the rusts has observed that the teleutospores are often very irregular in their general shape, number of cells, and the relation of the cells to one another. This fact has frequently been recorded, and is often referred to in books and papers on the Uredineæ. In studying the teleutospores of *Puccinia windsoriæ* Schw., collected in a scattered maple grove on the "bottom land" bordering a small creek near Lincoln, Neb., March 31, 1898, on *Muhlenbergia racemosa* B. S. P., I found some more than usually interesting forms, which are shown in the accompanying plate.

In the genus to which this species is referred there are two cells in the teleutospore, as shown in Figs. 21–26, but a reference to the plate shows one-celled, two-celled, three-celled, four-celled, and five-celled forms. Normally also the two cells lie in the extension of the axis of the pedicel, as in Figs. 21–23 and 25, but all kinds of departures from the normal may be observed on the plate. Out of 572 spores counted in several mounts from different leaves, the microscope fields being taken at random, I found 27 abnormal spores, or about 4¾ per cent. On some leaves the proportion of abnormal spores was much higher, and in one cluster of 11 spores still holding together in the mount, five had more than two cells.

Of the 572 spores referred to above —

1 (or 1.93 per cent) were three-celled, with septa parallel.
12 (or 2.10 per cent) were three-celled, with septa in two planes.
1 (or .17 per cent) was four-celled, with septa in one plane.
1 (or .17 per cent) was one-celled.
2 (or .35 per cent) were turned upon their pedicels.

In other mounts I found several four-celled spores, with the septa in two planes, as in Figs. 16, 18, and 20.



FIGS. 1 and 2.—Three-celled form, with single cell basal. Figs. 3 and 13.—Two-celled form, turned upon the pedicel. Figs. 4, 5, 8, and 10.—Forms intermediate between 1, 2, and 9, 11, 14, 15, 17. Fig. 6.—Two-celled form, with lower cell branched. Fig. 7.—One-celled form. Figs. 9, 11, 14, 15, and 17.—Three and four-celled forms, with septa parallel. Figs. 12 and 19.—Three-celled form, with single apical cell. Figs. 16, 18, and 20.—Four-celled form, with septa at right angles. Figs. 21 to 26.—Normal form. (Scale of micro-millimeters on plate.)

If the variations found in these specimens were to become permanent, we should have representatives of at least four genera in this single species, or we should have to discard or modify our present notions as to the relationship and classification of Uredineæ. It may be that the morphology of the teleutospore is not to be considered of as much importance as we have supposed. One-celled teleutospores (Fig. 7) are common, and if these should eventually predominate the species must be referred to Uromyces, or Melampsora, instead of Puccinia. If such forms as Figs. 1, 2, 12, and 19 become most common, we must refer the species to Triphragmium. The forms shown in Figs. 16, 18, and 20 may be allied to the latter, with an additional septum. If spores like Figs. 4, 5, 9, 11, 14, 15, and 17 were most numerous, we could not avoid referring the species to the genus Phragmidium. Yet all these forms have been found in this species, often on the same leaf, and nearly all have occasionally been found in the same sorus. In my specimens nearly every leaf contained a number of several-celled spores, but I found them more numerous on the leaves which lay near the ground, those which stood free in the air bearing fewer abnormal spores.

The normal spores agree well with Burrill's description in his "Parasitic Fungi of Illinois,"[1] though more variable in size. I measured 58 spores and found them to be 16.8 to 24 μ by 26.4 to 48 μ, averaging 20.8 by 34.3 μ, while Burrill's measurements are 18 to 21 by 27 to 30 μ.

I have examined herbarium specimens of this species from Iowa, Illinois, and Nebraska (Lincoln, 1889), but found no spores with more than three cells.

UNIVERSITY OF NEBRASKA.

[1] Parasitic Fungi of Illinois, Pt. i, Uredineæ, by T. J. Burrill, in *Bull. Ill. State Lab. Nat. Hist.*, 1885.

EDITORIAL.

A Marine Biological Station for Canada. — At the Toronto meeting of the British Association, a proposition was brought forward in the Botanical Section for the establishment of a biological station in the Gulf of St. Lawrence. So strongly did this appeal to those interested that the Sections of Zoology and Physiology asked to be allowed to participate in the movement, with the result that a committee was appointed to take such steps as might be necessary. This committee consisted of Prof. E. E. Prince, Chairman; Dr. A. B. Macallum, Prof. John Macoun, Dr. T. Wesley Mills, Prof. E. W. MacBride, Dr. W. T. Thistleton-Dyer, of the Royal Gardens, Kew; and Prof. D. P. Penhallow, Secretary.

In March last this committee, supported by a very strong deputation representative of the fishing interests and of the leading universities of Canada, approached the government through the Minister of Marine and Fisheries with the request that an appropriation be made to cover the cost of establishing such a station for a certain term of years.

According to the terms of the request, the station is to be a floating one, and will be established in the Gulf of St. Lawrence for a period of five years; it will be established first on the south shore of Prince Edward Island, and be moved annually to a new location as required; the various universities and scientific bodies of Canada will be granted certain privileges with respect to opportunities for qualified investigators; the scientific work will be executed as far as possible by experienced investigators connected with the various universities; that while the station remains a government institution, the administration is to be vested in a Board consisting of one or more representatives from the Department of Marine and Fisheries, and one representative from each of the leading universities.

The committee received a favorable reply to its request, and the government made an appropriation of $7000 to cover cost of construction and outfit and expenses for the first year, thus substantially guaranteeing its support for the experimental period of five years.

The Board of Management, as now constituted, consists of Prof. E. E. Prince, Director; Prof. D. P. Penhallow and Prof. E. W.

MacBride, of McGill University; Prof. Ramsay Wright, of Toronto University; Prof. L. W. Bailey, of the University of New Brunswick; Prof. A. P. Knight, of Queen's University; Rev. V. A. Huart, of Laval University.

It is probable that all plans will be perfected during the coming winter, so that active work may commence with the opening of the season of 1899. It would be altogether premature to discuss the policy of this station, but there is reason to believe and hope that it may establish such relations with kindred institutions as to prove of mutual advantage without intruding upon the special work now carried on in other localities. Its future will be watched with much interest.

REVIEWS OF RECENT LITERATURE.

A Teacher's Guide in Nature Study. — Teachers who appreciate the importance of enriching elementary education by natural history studies, and realize something of the difficulties to be met, will doubtless greet with hopeful interest the announcement of a school-teacher's contribution toward a solution of the problem.[1] Although on the title page it is said to be "for teachers and pupils," a perusal of the book shows it to be little more than a guide for teachers, and quite unsuitable for children's use. Its purpose is better indicated in the preface as an attempt "to point out some of the material which may be made the basis of profitable lessons in nature study," and an endeavor "to show how this material may be made available, and what the pupils may be taught about it."

In his effort to suggest profitable lines of instruction the author has had some measure of success. The natural interests of children are followed in calling attention to common animals, plants, and rocks, and indicating how each affects the others. Questions are asked which are calculated to stimulate observation. Simple and significant experiments are encouraged. Regarding certain of the objects dealt with, notably domestic animals and cultivated plants, there is given information likely to be of service to teachers in preparing nature lessons. References to good literature on the various topics are not infrequent, although sometimes their value is lessened by lack of definiteness. The illustrations, a good share of which are original, are generally good.

On the other hand, it must be said that the book gives the unfortunate impression of being mainly a collection of notes prepared by the author for use in his daily lessons with children, some of the notes being the merest skeletons of topics for treatment, while others are expanded as examples of the way he would talk to a class. There often results a somewhat puzzling mixture of the audiences supposed to be addressed, and much of what is said seems entirely unnecessary. There are, moreover, frequent evidences of hasty preparation,

[1] *Handbook of Nature Study for Teachers and Pupils in Elementary Schools.* By D. Lange, Instructor in Nature Study in the Public Schools of St. Paul, Minnesota. The Macmillan Company. New York, 1898. xvi + 329 pp. 60 illustrations. Cloth, 12mo, $1.00.

slips in English, and loose statements. Misstatements and misuses of technical terms are altogether too numerous, even for a first edition. Of these a few examples must suffice. On page 233 we read that the Kentucky coffee tree "has the most compound leaves of all American trees"; on page 2 a tulip flower is said to consist of six leaves; on page 187 occurs the statement that "corn is the only grass which bears the sterile and fertile flowers on separate heads"; and on page 4 sepals are called leaflets. In spite of these defects, however, we should say that teachers may gain from this book not a little of profitable fact and hint if they are disposed to have due patience in overlooking much that seems crude and practically valueless.

FREDERICK LEROY SARGENT.

Needham's Outdoor Studies.[1] — With the rapid development of "nature study" in the American schools has come a marked increase in the putting forth of nature study books. A good nature study book should be, above all, truthful; its telling of nature should be accurate. Then it should be readily comprehensible, and written so as to attract and to hold the interest of its intended readers, be they teachers or children or both. Professor Needham's little book possesses the qualifications just enumerated. The author is a careful and intelligent naturalist, and writes from personal observation and experience. He writes simply, and he writes interestingly. *Outdoor Studies* is certainly one of the good nature study books.

The book is written, suggests the author, especially for the children. It is insistent in its demands for personal work by the student in "seeing and doing and thinking," and explicit in its explanations of how to do this work. There are chapters on flowers and insects and chipmunks and birds under such titles as "Butter and Eggs and Bumblebees," "Goldenrod, its Visitors and Tenants," and "Houses that Grow" (galls and gall insects). The book is charmingly and helpfully illustrated, and the big scientific names, whose value is not overlooked but whose fear-inspiring capacity is fully recognized, are disposed of in a unique and effective way. Altogether the book is one to recommend to teachers, to parents, and to the children, for whom it is primarily written.

V. L. K.

STANFORD UNIVERSITY, CALIFORNIA.

[1] *Outdoor Studies, A Reading Book of Nature Study.* By James G. Needham. Eclectic School Readings, American Book Company. New York, 1898.

ZOOLOGY.

Parker and Haswell's Zoology.[1] — For many years there was no greater need in teaching zoology than a good text-book on the subject — one which should treat the subject from a modern morphological standpoint. One need not go back more than four or five years to find the time when Sedgwick's translation of Claus was the only such work available. This real need has been met, and perhaps more than met, in the last few years by the translation of several works from the German, and by new publications in the English language. Among the books on this subject which have been anxiously awaited by teachers of zoology was the long-promised work by Parker and Haswell, which has recently appeared. Parker's text-book on zootomy and on elementary biology were evidence that one of the authors, at least, thoroughly understood the needs of the elementary student. It may be doubted whether any book in any language presents the facts of elementary biology in a more attractive manner than does Parker's text-book on this subject; and it was to have been expected that the new book on zoology would be preëminently a student's text-book, clear, concise, and attractive. In this respect no one will be disappointed with the work. The authors show at every step that they are, before all else, teachers, and that they know how to present the facts of zoology in a way which, even to the laity in such matters, is intelligible, interesting, and instructive.

In spite of its size the authors expressly affirm that the work is addressed to the needs of elementary students, but it is to be feared that both the size and the cost of the work will effectually prevent its coming into very general use among persons of this class. Almost all recent English works on zoology seem to show that it is no longer possible to condense into a single volume the elements of the whole science. On the other hand, some notable German text-books on this subject are much more limited in extent, while no less accurate and satisfactory; *e.g.*, the works of Boas and Hertwig occupy, respectively, 578 and 576 pages, and few, if any, better text-books on zoology can be found in any language. Hatschek's work is unfortunately still a fragment, but where is there another such a text on the field which it covers? These German works show that it is possible to

[1] Parker, T. Jeffery, and Haswell, William A. *A Text-Book of Zoölogy.* Macmillan & Co. 1897. 2 vols., 779 pp. and 683 pp.

present the subject within a single volume, and in a manner which is both thorough and attractive. And by this same showing it is evident that the book which will be used by large numbers of English students has not yet appeared.

The distinctive feature of Parker and Haswell's work is the way in which the study of "types," or "examples" as our authors prefer to call them, is united with the more usual methods of descriptive zoology. Believing that definitions and general descriptions can be useful only after the student has obtained some first-hand knowledge of the things described, our authors begin the study of every group with a description of some single example of that group, which should be thoroughly studied in the laboratory before undertaking the study of the group as a whole. The value of this departure, no one who is a thorough believer in the laboratory method can for a moment doubt; that it has its dangers none can deny. If the study stops with a few examples, it is narrow and misleading; if it covers the whole field by means of a text-book and a few museum specimens, it is superficial. A proper combination of the two methods, which would secure the advantages and avoid the disadvantages of both, would be ideally perfect.

Such a combination our authors have attempted, and, as it seems to us, with signal success. "Every group which cannot be readily and intelligibly described in terms of another group" is represented by an example. The descriptions of these examples are concise and yet comprehensive, and this part of the work might well be used as a laboratory guide were it not for the fact that the authors have been so cosmopolitan in their choice of examples, some of which are peculiar to Australia, others to New Zealand, others to Great Britain, and still others to the Mediterranean. In most cases, however, alternative forms are suggested which might serve in the place of the example described.

Following the description of the examples there is given the classification of the group which it represents, then a detailed description of its various subdivisions, and finally a general discussion of the organization, embryology, ethology (œcology), distribution, and affinities of the group as a whole.

In accordance with the plan of presenting specific facts before the general ones, the discussion of distribution, the philosophy of zoology, and the history of zoology, with references to the general literature, is put at the end of the work. However, in order to render the body of the work intelligible to elementary students there is at the begin-

ning a general introduction on the subjects of classification, anatomy, and physiology.

In spite of many excellences, the general part of the work is not wholly satisfactory; it is distinctly inferior to the *Allgemeine Zoologie* of Claus, Hertwig, or Hatschek. Again, it seems to the writer unwise, both from a pedagogical and from a scientific standpoint, to erect any artificial barrier between the philosophy and history of a science and its bare results. The deadest, driest facts may be clothed with a living interest if only the historical discovery of those facts and their philosophical import are pointed out at once.

Twelve phyla of the animal kingdom are recognized instead of the classical seven of Leuckart, the modifications being the following: the Porifera are separated from the Cœlenterata; Vermes is omitted, and in its place are three phyla, *viz.*, Platyhelminthes (including Nemertinea), Nemathelminthes (including Chætognatha), and Annulata; a new phylum, Trochhelminthes, includes Rotifera, Dinophilea, and Gastrotricha; Molluscoidea stands as a phylum, including Polyzoa, Phoronida, and Brachiopoda.

The first eleven phyla are treated of in the first volume of the work; the second volume is devoted entirely to the twelfth phylum, the Chordata. Each volume is indexed and is complete in itself, and this fact may be utilized to advantage by teachers who conduct separate classes in Vertebrate and Invertebrate Zoology.

The illustrations and typography are excellent in the main. Some of the figures suffer from being copies of copies, but many of them are entirely new, and others are new to a text-book. Both the illustrations and the method of presenting the subject give a freshness to the whole work which is very attractive.

Unfortunately the work is marred by an unusually large number of errors.[1] This is certainly due in part to the fact that the authors were separated so far from each other and from the publishers, and perhaps also to the serious illness of the senior author, who, unfortunately, did not live to see the completion of the work.

Some Recent Faunistic Work in Europe. — Two papers of importance have appeared recently which deal with the fresh-water fauna of Central Europe and exemplify in some particulars the tendencies of current faunistic and systematic work in zoology. For many years Bohemia has been a center of activity in these lines, and the portable

[1] For a list of these errors see a review of the work in *Natural Science* for March, 1898.

biological station under the direction of Professor Frič has had a large share in this work. The latest publication from this station is a paper[1] which deals with the flora and fauna of two glacial lakes in the Bohemian Forest. These lakes have an altitude of 1008 and 1030 meters, and a maximum depth of 30 and 35 meters, respectively. They are characterized by rocky shores, little vegetation, and great transparency of the water. As might be expected under these conditions the fauna is scanty, including, with the adjacent land forms, only 185 species, of which but 83 are referred to the aquatic fauna. This is characterized by the presence of a number of cosmopolitan species, principally of Protozoa and Entomostraca, together with a much smaller number of alpine and arctic forms. The cosmopolitan distribution of the two groups above mentioned is shown by the fact that of 19 species of Protozoa listed for these Bohemian lakes, 13 are known to occur in this continent, and of the 24 species of Entomostraca at least 12 are found in American waters. A further evidence of the similarity of the lake fauna the world over is found in the occurrence in these alpine lakes of Bohemia of 12 species, largely limnetic, reported by Forbes[2] from the mountain lakes of Yellowstone Park.

These lakes of Bohemia were under observation in 1871, in '87, and again from '92–'96 at intervals during the summer months. With respect to the fauna thus observed, the authors conclude that it is not constant but changes from year to year in response to the environment, predominant forms of one year disappearing the next, it may be to return again when conditions favor. Thus the authors attribute the disappearance of *Polyphemus pediculus*, a littoral species in Schwarzersee, to the accidental lowering of water level, whereby the winter eggs were stranded on the dry shore, and the extermination of *Holopedium gibberum* from the plankton to the introduction of *Salmo salvelinus* into the lake. A single fish (32 cm.) of this species was taken which had eaten 3000 specimens of Holopedium. The plankton is remarkable for the paucity of species reported. In general the collections, which were not strictly quantitative, indicate an accumulation of the plankton in the upper layers and its scarcity in the deeper water, though one instance occurs of an exceptional abundance of *Daphnia ventricosa* — with summer eggs — in the

[1] Frič, A., und Vavra, U. Untersuchungen zweier Böhmerwaldseen, des Schwarzen und des Teufelssees. *Archiv f. Landesdurchforsch. v. Böhmen*, Bd. x (1897), Nr. 3, 74 pp., 33 figs.

[2] Forbes, S. A. A preliminary report on the aquatic invertebrate fauna of Yellowstone National Park, Wyoming, and of the Flathead region of Montana. *Bull. U. S. Fish Com.*, vol. xi (1893), pp. 207–258, Pls. XXXVII–XLII.

bottom water at a depth of 25 meters. The bottom ooze of the lakes is declared to be practically devoid of life.

The second paper[1] is issued by the Balaton Lake Commission of the Hungarian Geographical Society, as Part I of a volume dealing with the biology of this body of water, a lake containing 650 square kilometers, but having an average depth of only 3 meters and a maximum of 10. The presence of vegetation, the warm shoal water, and the variety of conditions offered in so large a body of water favor the occurrence of an extended and varied fauna. It is therefore not surprising that the zoological inventory includes 597 species reported by the specialists who have dealt with the various groups.

The introductory chapter by Dr. Entz contains a description of Daday's ingenious closable trap for bottom collections and an extended comparison of the pelagic fauna of the Balaton with that of other bodies of water which have been similarly explored. Owing to the fragmentary character of the data, precise comparisons are not possible, though in a general way it may be said that the organisms of the plankton are, as a rule, cosmopolitan in their distribution. Attention is called to the invasion of the littoral region by the plankton organisms and the depth of 1.5 meters is stated to be the limit of the purely plankton-inhabited area of Lake Balaton. That this limit cannot be generally applied must be evident. The reviewer has often found a typical plankton in water much less than a meter in depth. The character and extent of the littoral fauna, and especially of the flora, the distance from shore, and a host of environmental conditions come in to establish, obliterate, or modify the boundary lines of the limnetic and littoral areas in most bodies of fresh water. Aquatic vegetation is said to hinder the development of the plankton, and the author maintains the diurnal migration of the plankton organisms, — to the surface at night and to the deeper waters during the day. No data upon this subject are given, and it may be well in this connection to recall the results of Professor Birge's careful quantitative work[2] upon the movements of the *Crustacea* in Lake Mendota. In this body of water the diurnal migration, occasioned by the light, is confined to the upper meter or possibly two meters.

[1] Die Fauna des Balatonsees, von Dr. K. Brancsik, Dr. E. v. Daday, R. Francé, Dr. A. Lovassy, L. v. Méhelÿ, Dr. S. v. Ratz, Dr. K. Szigethy, und Dr. E. Vángel, unter der Leitung von Dr. G. Entz. Wien, 1897. xxxix + 279 pp. 158 illustrations.

[2] Birge, E. A. Plankton Studies on Lake Mendota. II, The Crustacea of the Plankton, July, 1894 — December, 1896. *Trans. Wisc. Acad. Sci., Arts, and Letters*, vol. xi (1897), pp. 274–448.

The plankton of the Balaton is peculiar in its entire lack of Dinobryon and Difflugia. The fauna seems to be relatively poor in Rotifera and Entomostraca and rich in Nematoda and Protozoa, especially Flagellata. For these last particulars much credit must be given to the excellent reports of Daday and Francé. Of the Protozoa 191 species were found, 92 belonging to the oft-neglected group of Mastigophora. The bottom ooze yielded an unusual number of new forms.

With regard to the distribution of Protozoa, Francé concludes that it is not so much influenced by climatological and meteorological conditions, as by the hydrological environment and the associated vegetation. Thus he distinguishes several characteristic habitats, each having its peculiar protozoan fauna wherever found, such as (1) the peat swamp where desmids and Protococus abound, and the green flagellates as Euglena are plentiful; here we find the Rhizopoda with patterned shell, such as Euglypha and Nebella, which feed upon the green forms mentioned; (2) decaying vegetation, where Stentor, Paramœcium, and craspemonads occur; (3) the rush-bordered shore, where diatoms abound, and the diatomophagous Protozoa, such as Amœba, the Euglenidœ, Chilodon, Holophrya, and Amphileptus, abound; (4) the bottom ooze, resembling the shore but not so densely populated, where *Amœba verrucosa*, Arcella, and Difflugia, and small monads are to be found; (5) the sandy shore, marked by the sand building Rhizopoda, as Difflugia, and Orbulinella; (6) the rocky shore, where filamentous algæ cover the rocks and afford food and shelter for the algophilus Infusoria, such as Glaucoma and Colpoda, and for the thalamophorous Rhizopoda; (7) the open water with its typical plankton forms, such as the Peridinidæ, Codonella, Synura, and the passive limnetic Epistylis and Tokophrya. It is of interest to note that Daday finds these same habitats characterized each by its peculiar crustacean fauna. He also mentions the avoidance of the upper layers of water by the Entomostraca in the daytime and on moonlit nights, and discusses their movements with respect to light.

An interesting case of "synoikosis" is reported by Vángel in which a bryozoan, *Fredericella sultana*, is associated with a sponge, *Spongilla lacustris* or *fragilis*. There is a marked and constant agreement in the color of the two forms, the bryozoan being of a grayish, brownish, or greenish tinge according as the sponge is colored. The author suggests that the similarity in color affords mutual protection, that the tentacles of the bryozoan create currents which bring more food to the sessile sponge, and that by reason of its

likeness in color to its background the bryozoan escapes detection when extended from its capsule. From the structure of the sponge it is evident that it is not located upon the bryozoan until the latter has attained a considerable growth.

Although a considerable number of new species are described in this report, we find an occasional reduction of an old species to a synonym as a result of the examination of this fauna through several seasons, and a few incidental references to the variability of characters relied upon for specific distinctions.

Charles A. Kofoid.

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Lake Fauna. — The results of three summers' careful investigation of the life in a small lake in Finland are given in a faunistic-biological paper by Dr. K. E. Stenroos,[1] which amply proves the sufficiency of a small body of water to yield a rich fauna and to throw light on many important biological problems. Lake Nurmijärvi contains but two square kilometers, is but one meter in depth, presents a variety of shore formations, and is rich in vegetation. It is subject to considerable fluctuation in level and in temperature and to much shifting of the bottom by the ice in winter.

The author's faunal list includes 460 species, of which 157 belong to the Rotifera and 98 to the Entomostraca. The absence of nematodes, the paucity of Infusoria, and the small number of aquatic insects enumerated are probably due to the lack of especial attention to these groups, such as was given to the Rotifera. In this latter group 27 new species are described — the under surface of lily-pads having proved to be an inexhaustible source of new forms. In this list of Finland rotifers are to be found three species discovered by Jennings[2] in the Great Lake region of this continent. Among the Entomostraca Stenroos finds a seasonal polymorphism which renders necessary a considerable reduction in the number of species in this group. Thus from spring to autumn *Hyalodaphnia jardinii* is successively represented by forms which have been described as *H. obtusata*, *berolinensis*, *cucullata*, *kalbergensis*, and *autumnalis*. Likewise in the genus Bosmina the author admits but five species,

[1] Stenroos, K. E. Das Thierleben im Nurmijärvi-see, eine faunistisch-biologische Studie. *Acta Soc. pro Fauna et Flora Fennica*, Bd. xvii, pp. 1–259, Taf. I–III, mit einer Karte.

[2] Jennings, H. S. A List of the Rotatoria of the Great Lakes and of Some of the Inland Lakes of Michigan. *Bull. Mich. Fish Com.* (1894), No. 3. 34 pp., 1 pl.

the remaining twenty-two being recognized as varieties, or in some instances as mere seasonal or habitat forms. Two types of contemporaneous males are described for *B. brevirostris*, and are also stated to occur in *B. lilljeborgii*. One of the two exhibits a marked resemblance to the female in its secondary sexual characters, — armature of the post-abdomen and structure of the antennæ. The author suggests that this dimorphism may be serial in the life history of the male, representing two stages separated by a molt.

Although the lake is a small one, it presents a number of well-marked faunal areas, determined largely by the nature of the substratum and of the vegetation. Full lists are given of the characteristic faunas, and the adaptations exhibited by their constituent organisms are discussed at length. We note that no mention is made of the pelagic habit of many Rhizopoda, and that the author ranks Dinobryon, Hyalodaphnia, and Diaphanosoma as tycholimnetic organisms — forms which in most bodies of water are typical planktonts. Attention is called to the uneven distribution of the Cladocera occasioned by the influence of light. At night they are dispersed through the water, on cloudy days they congregate in the upper strata, but on bright days they gather in great swarms on the sunny side of clumps of Scirpus, shifting their position as the day advances. The Copepoda and Ostracoda, on the other hand, appear to be indifferent to the influences of light to which the Cladocera show so marked a response.

CHARLES A. KOFOID.

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The Embryonic Development of the Wall-Bee (Chalicodoma muraria Fabr.)[1] — Prof. Justus Carrière's untimely death in 1894 left his valuable study of the embryology of the wall-bee incomplete. The notes and preparations of the Strasburg savant have been saved from oblivion by Dr. Otto Bürger, of Goettingen, and published in a fine quarto with thirteen excellent plates. The first part of the work, dealing with the formation of the germ-layers, is wholly the work of Carrière ; the second part, by Bürger, is based on Carrière's preparations, notes, and sketches.

The work is of peculiar interest as the latest and most complete account of the embryonic development of a hymenopterous insect.

[1] Die Entwickelungsgeschichte der Mauerbiene (Chalicodoma muraria Fabr.) im Ei, v. Dr. Justus Carrière, herausgegeben und vollendet v. Dr. Otto Bürger. *Nova Acta, Abh. d. kaisl. Leop.-Carol. Akad. d. Naturforscher*, Bd. lxix (1897), Nr. 2, pp. 255–419, Taf. XIII–XXV.

Up to the present time the papers of Grassi (1884) and Bütschli (1870) on the development of the honeybee, contained nearly all our knowledge of hymenopterous embryology. The Hymenoptera are interesting as a highly specialized insect type, and the observations contained in Carrière's and Bürger's monograph are valuable because they enable us to appreciate more fully the peculiarities in the development of the more generalized insect orders (Apterygota, Dermaptera, Orthoptera, Odonata, Hemiptera, etc.). It also appears that certain problems, such as the origin of the germ layers, can be studied, as Carrière and Bürger show, to greater advantage in the bee than in any other insects hitherto investigated, because the embryo always remains on the ventral surface of the egg, and is never longer than the egg, *i.e.*, its posterior end neither curls over to the dorsal surface of the yolk as in Coleoptera, Diptera, etc., nor becomes imbedded in the yolk as in Hemiptera and certain Orthoptera. Other advantages of a technical character are the liquid yolk, which is easily sectioned, the thinness of the shell (chorion), and the large size of the egg. These advantages have enabled Carrière and Bürger to make an accurate study of the formation of the germ-layers. Their conclusions are essentially the same as those published by Heider and Wheeler in their studies of Coleoptera (*Hydrophilus* and *Doryphora*). The entoderm arises from two widely separated regions of the blastoderm, one at the anterior, the other at the posterior end of the blastodermic groove which gives rise to the mesoderm. The anterior entoderm rudiment sends back a pair of cellular, band-like prolongations under the mesoderm, while the posterior rudiment sends a similar pair forward. The prolongations of corresponding sides meet and then envelop the yolk by spreading dorso-ventrally. During this process the mesoderm is constricted off from the blastoderm in the mid-ventral line, and the stomodæal and proctodæal invaginations form, respectively, over the anterior and posterior entoderm rudiments. The formation of the stomodæum and proctodæum is so closely associated with the origin of the two entoderm rudiments that one investigator, Heymons, has boldly denied the existence of an entodermal germ-layer in insects. Heymons derives the whole alimentary tract from the ectoderm (!). Bürger, however, very justly dissents from this view. He shows that the entoderm arises from the *undifferentiated* blastoderm, and that the stomodæal and proctodæal invaginations arise from the superficial layer of blastodermic cells, the only layer that can properly be called ectoderm.

There are many interesting new facts in the portion of the paper devoted to a description of the organs arising from the different germ-layers. Carrière discovered a pair of minute evanescent appendages on the first brain (protocerebral) segment, and another pair on the third brain (tritocerebral) segment. Bürger confirms the accounts of preceding writers who claim that the antennæ arise from the second brain (deutocerebral) segment. Three pairs of oral appendages and three pairs of thoracic appendages are formed as in other insects, the latter notwithstanding the fact that the bee has an apodal larva. The thoracic appendages, however, soon flatten out, and Bürger finds that their hypodermal cell-layer thickens and becomes the imaginal disks, which, in the larva, are the rudiments of the legs of the imaginal bee. This interesting observation should be brought to the notice of those investigators who regard the gonapophyses of insects as dyshomologous with ambulatory legs, for the reason that the gonapophyses develop from larval structures resembling imaginal disks (Heymons). Bürger claims that he was unable to find rudiments of abdominal appendages on more than the first to fourth segments. His figures 28 and 35, however, show them on all the abdominal segments as in many insects more primitive than the bee. The pairs on the eighth, ninth, and tenth segments are peculiarly distinct and are evidently the rudiments of the gonapophyses (ovipositor). Bürger nowhere mentions these structures.

Another valuable observation made by Bürger is the presence in the embryo of the imaginal disks of the wings. Weismann and Graber claimed to have found these in the embryos of the blowfly, but their accounts are far from being satisfactory. The wing-disks of the bee arise as a pair of hypodermal thickenings with subjacent accumulations of mesoderm cells lateral to the leg disks in the meso- and meta-thoracic segments. They are beautifully shown in Bürger's Fig. 173. The labrum arises as a pair of discrete appendages in front of the stomodæum. These ultimately fuse in the middle line.

The origin of the tracheæ, spinning glands, tentorium, and flexor mandibulæ are described in detail. The tentorium is formed from two pairs of ectodermal invaginations resembling tracheal pits in the mandibular and second maxillary segments. The flexores mandibularum arise from a similar pair of invaginations in the first maxillary segment. The spinning glands are derived from a pair of invaginations immediately behind the second maxillary segment. The Malpighian vessels arise, as Carrière has shown in an earlier paper,

before or during the invagination of the proctodæum, as two pairs of depressions in the ectoderm of the anal segment.

Bürger describes the formation of the midgut, or mesenteron, in detail. The vitellophags left in the yolk when the segmentation cells are migrating to the surface to form the blastoderm, in the later stages of development arrange themselves on the surface of the yolk as a continuous epithelium immediately inside the entoderm. This vitellophag layer, however, forms no portion of the definitive midgut wall, but disintegrates towards the close of embryonic life, just as the scattered vitellophags disintegrate in other insects.

Bürger's account of the nervous system of the Chalicodoma embryo is mainly valuable as a confirmation of the observations of Heider, Wheeler, and Viallanes on other insects. Carrière and Bürger regard the frontal ganglion as the first segment of the brain, and the labrum as its pair of appendages. Their interpretation of the remaining head segments is the same as that of the above-mentioned authors. The ventral nerve chord is derived from neuroblasts similar to those found by Wheeler in Doryphora. The ganglionic cells budded off from the neuroblasts are not in regular rows as in the Orthoptera (Xiphidium, *e.g.*). The account of the origin of the Mittelstrang is unsatisfactory. Bürger agrees with preceding writers in deriving the ganglia of the sympathetic nervous system from the dorsal wall of the stomodæum. The "ganglia allata" which Heymons discovered in Forficula arising from a pair of invaginations near the base of the maxillæ and subsequently moving around and uniting on the dorsal surface of the stomodæum, are probably not ganglia at all, if certain large structures found by Bürger in corresponding positions in the bee should prove to be homologous with the bodies observed by Heymons.

The development of the body-cavity (schizocœle) is traced by Bürger, together with the portions of the walls of the cœlomic sacs that give rise to the heart, pericardial septum, pericardial fat-body, the main mass of the corpus adiposum, the ventral and dorso-ventral musculature. The heart is formed from two rows of cells (cardioblasts), which move towards each other around the yolk and finally unite to form a tube in the mid-dorsal line. The deutocerebral is the only head segment that contains a pair of mesoblastic somites with distinct cœlomic cavities.

Carrière finds the first traces of the reproductive organs in embryos with the full number of segments and the appendages beginning to bud out. They appear as large cells in the walls of the mesoblastic

somites of the third, fourth, and fifth abdominal segments. These cells, which seem to be restricted to the dorsal wall of their respective somites, subsequently collect about a common center to form on either side a small oval body, — the ovary or testis. The vasa deferentia and oviducts arise from the mesoderm. The former terminate in the tenth, the latter in the seventh abdominal segment, in both cases in terminal ampullæ as described by Wheeler for Xiphidium. A thickening of the hypodermis over the terminal ampullæ represents the rudiment of the ectodermal portions of the reproductive organs (ductus ejaculatorius and vagina).

The embryonic envelopes of the Hymenoptera promise to yield interesting results when carefully investigated. In the Phytophaga the envelopes are complete and typical, as shown by Graber in *Hylotoma berberidis.* In the other Hymenoptera hitherto studied only one envelope, the amnion, is formed. Carrière shows that it arises in the wall-bee from the peripheral portion of the blastoderm and persists only a short time. The exact mode of its obliteration is not clearly figured or described. By the time of hatching it has almost completely disappeared. Bürger claims that embryos of *Polistes gallica*, at least in the later stages, agree with Chalicodoma in possessing only a single embryonic envelope, and that this also disappears before the hatching of the larva.

WILLIAM MORTON WHEELER.

Tumors and Germ-Layers. — Since tissue differentiation in organisms has come to occupy so large a place in the attention of biologists, the general subject of tumors has assumed a biological interest that is but little less than its medical interest.

A recent paper by Dr. D. Montgomery, with a note by Dr. L. F. Barker,[1] dealing with a case of teratoma, contains so much of interest that it deserves to be more widely known to biologists than it is likely to become through the pages of a medical journal. The tumor was taken from the peritoneal cavity of a girl twelve years old. It was of the solid variety, *i.e.*, it was not a single large cyst, but was a mass of tissue with a great number of small cysts scattered throughout its substance. Its weight was two pounds. It was situated on the right side of the abdomen, and was attached to the ascending

[1] A Teratoma of the Abdominal Cavity, by Dougless W. Montgomery, M.D., with a Note on Dr. D. W. Montgomery's Case of Teratoma, by Lewellys F. Barker, M.D. *The Journ. of Experimental Medicine*, vol. iii (May, 1898), No. 3, pp. 259–292.

colon throughout nearly its entire length, as well as to the adjacent peritoneum. According to Dr. W. F. McNutt, who performed the operation, the abdominal veins were dilated, but the tumor cleaved out easily and apparently completely. No large vessels were encountered during the removal beyond "such as run in brittle adhesions," though the peritoneal surface, from which the growth was removed, was left raw and bleeding.

The tumor "contained tissues and portions of organs corresponding in embryonic origin to all the germinal layers. Corresponding to the epiblast there were skin with cutaneous organs and appendages, central nervous system, peripheral nerves, and the rudiments of eye structure.

"The hypoblast was represented by mucous glands, tubes, and cysts, with epithelial lining and surrounded by smooth muscle. The mesoblastic tissues consisted of bone, cartilage, white fibrous tissue, yellow elastic tissue, mucoid connective tissue, adipose tissue, smooth muscle fiber, and blood vessels."

The nervous tissue was in large quantity, but no ganglionic cells were made out with certainty. Of the eye only portions of the pigmented layer of the retina, and possibly parts of the sclera, were found; but the former were so distinct and characteristic that both observers agree in considering error of identification as impossible. Highly significant concerning this tissue is the fact that "similar polygonal pigmented cells are to be seen irregularly distributed through the sections, sometimes apparently in solid portions of the tissues, sometimes lining small irregular slit-like spaces, and in one instance lining a space which is continuous with the cavity lined by ependymal epithelium, which probably corresponds to brain ventricle."

The blood in the vessels had all the characteristics of adult blood. No nucleated red cells were found. No trace of a heart was present.

After the operation the patient seemed to do well for a time, but in about a month it was found that the tumor was growing again, and it was removed a second time. The recurrent growth did not come away whole as did the first, as it was softer, more friable, and involved the peritoneum both more widely and more intimately than did the first. Like the original, "it contained tissues from all three germ layers. Indeed, all the structures met with in the original tumor could be found in various parts of the tissue removed at the second operation."

The authors discuss at some length the various theories concerning the origin of dermoid tumors, and both reach the conclusion that the *fœtus in fœtu* theory of Meckel explains most satisfactorily the present case. Biologically considered, some of the facts presented are very difficult to understand, even on this theory; *e.g.*, the widely distributed condition of the eye tissue and the recurrence of the entire tumor.

Dr. Montgomery assumes that some fragments of the original growth must have remained behind after the first operation, despite the fact that such did not seem to be the case; and that these fragments contained representatives of all the tissues found in the tumor.

W. E. R.

A New Journal of Parasitology. — The attention of naturalists was attracted last year by the announcement that the publication of a new journal devoted to the study of parasites would be entered upon in 1898 by Prof. Raphael Blanchard, of Paris, whose contributions to helminthology have been among the most valuable of recent years. And the belief was freely expressed that the journal would be successful from the start, and would take a high place in the periodical literature of science. The appearance of two numbers of about 180 pages each afford complete justification for this belief, and call for more than a passing notice.

The *Archives de Parasitologie* is to be a quarterly devoted, as the preface says, "to the study of (all) those organisms which are capable of causing disease in man and in the animals." Its scope, in consequence, is decidedly extensive, and deals with parasitology in the broadest sense rather than with helminthology merely. The numbers already issued present articles on bacteria, protozoa, worms, and arthropods, as well as on methods and apparatus, while mycology is also proclaimed to be within its sphere. On reading the prologue of Professor Blanchard one is forced to pause, and wonders whether after all such a field is not too wide to keep a circle of special readers interested; whether mycology and bacteriology, which have their own journals also, appeal in their special development to workers in zoology; and, finally, whether bacteriology in all its wondrous blossoming will not usurp the place of other topics; and yet the perusal of the numbers shows a remarkable balance of interest and influence. Nevertheless, here is an evident danger.

The contents of the numbers at hand deserve more specific mention as indicating clearly the character of the periodical. First should

certainly be mentioned the beautiful tribute to that "Altmeister der Helminthologie," Rudolph Leuckart, whose photograph opens the second part; and the verdict that, famed as he was by his researches, the greatest power of the man was displayed as a teacher, will be shared by his students in all lands to whom to-day even the mention of his name comes as an inspiration. Among the score or more of scientific contributions it is almost invidious to attempt a choice, and some of the shortest can hardly be passed without mention. Of most general interest are perhaps Artault's splendid investigation on the flora and fauna of the pulmonary cavities and Brault's diseases of tropical lands. Legrain's well-illustrated article on parasitic diseases of Algeria will be read with peculiar interest by the physician, while those who have spent weary hours wrestling with the dry bones of systematic confusion will hail with delight such articles as Shipley's revision of the Linguatulidæ and Stiles and Hassall's inventory of the Fasciolidæ. Railliet and Marotel's article on the pancreatic fluke, which is the first accurate account of this species, a discussion of phagocytic organs in ascarids by Nasonov, whose figures are valuable aids to the comprehension of this newly emphasized feature of nematode anatomy, and Verdun and Iversenc's note on cysticerci of the cerebral ventricles will each interest the zoologist while appealing most strongly to workers in particular lines. The latter article calls for especial mention by virtue of its admirable summation of recorded cases of this type.

Perhaps the most characteristic feature of all the articles is the evident desire, successfully realized in most cases, to treat subjects from the standpoint of the specialist and yet to interpret them in the broadest way possible. This is manifest also in the editorial notes, as witnessed in the discussion of vicissitudes of helminthological nomenclature, where a gentle but just rebuke is administered with all the delicate and proverbial courtesy of a Frenchman.

Following the original articles, of which the bulk of each number is made up, are several pages of notes, and a list of reprints received closes the part. This list is evidently destined to become a valuable quarterly summary of contributions to parasitology convenient of reference, since the arrangement is topical and praiseworthy in that the references are full and precise.

In general appearance the *Archives* demonstrates the expressed resolve of the founder "to neglect nothing to make the typography and illustrations irreproachable." The paper used is of fine quality, the type clear and pleasing to the eye, and the text-figures, which are

not sparingly employed, are of the best. The single plate thus far published is well executed, but to an American eye the prominence accorded the name of the publishers savors rather too much of an advertisement. The journal is, however, on the whole one of which both the founder and the scientific world may well be proud, and for which all will join in wishing that abundant success for the future which the present numbers promise.

Henry B. Ward.

The Weigert Methods. — Prof. C. J. Herrick has published in the *New York State Hospital's Bulletin* for October, 1897, a report upon a series of experiments with the Weigert staining methods. The author has in contemplation a study of the components of the cranial nerves in bony fishes, and as this rests largely on the myelination of the nerves, a careful study of the Weigert methods has preceded it. The results, satisfactory as well as unsatisfactory, are given for the different fixing reagents, mordants, etc., and form a body of valuable suggestions for those who propose applying these methods to the lower vertebrates.

BOTANY.

Britton and Brown's Flora.[1] — As a rule, large undertakings proceed slowly, and although Professor Britton's friends had known for some years that he was at work on a new manual of the general region covered by the familiar work of Dr. Gray, most of them were surprised when confronted with the first volume of the book in 1896. The prompt appearance of the second volume, and the publication of the third and concluding volume within less than two years from the appearance of the first, are no less surprising than was the early commencement of the work, and its industrious authors are to be congratulated on their energy and the perfection of their plans.

It was a happy thought, that of placing not only a description but a figure of each species in the hands of students at a price not too high for the rather cramped purse of the average botanist, and doing

[1] *An Illustrated Flora of the Northern United States, Canada, and the British Possessions, from Newfoundland to the Parallel of the Southern Boundary of Virginia, and from the Atlantic Ocean Westward to the 102d Meridian.* By Nathaniel Lord Britton, Ph.D., and Hon. Addison Brown. In three volumes. New York, Charles Scribner's Sons. Vol. iii, Apocynaceæ to Compositæ, 1898, 4°, pp. xiv + 588, many figures in the text.

it has led to the illustration of 4162 species, belonging to 1103 genera and 177 families, by figures drawn from nature for the work. No less commendable is the effort to bring together in the index all of the popular names employed for the wild plants of the region covered — a task in which the scholarship of Judge Brown has proved no less serviceable than the botanical acumen of Dr. Britton in the management of the systematic details.

As a general thing, floras of regions that have been so long and so well studied as the eastern United States are compends of species which have been published previously in monographs of genera, accounts of special collections, and the like, their chief value consisting in the skillful elimination of insufficiently grounded species and the provision of keys of all grades, by which rapid and accurate diagnosis is made of those which are maintained. The *Illustrated Flora* claims conservatism in the admission of new species, but admits that "it is better to err in illustrating too many forms, rather than in giving too few"; and besides splitting composite species into forms which really conservative botanists are disposed to unite, it contains, especially in the third volume, a considerable number of original descriptions which will render its possession indispensable to future students of the American flora, whether they agree with its authors or not. Especial attention should be called to the dozen or more asters characterized as new species, not to mention the very large number of forms in the same genus which are given new varietal names, as a result of the preliminary revision of this difficult genus by Professor Burgess.

No descriptive manual of recent times is likely to be more diversely judged by the botanical public than the one under review. Its aims are excellent. Its keys and figures usually give a Latin name for any individual specimen, and the non-professional user, by following the naïve suggestion to use the index of common names in connection with the figures, is likely to make surprising and no doubt gratifying progress in the acquisition of this sort of information. But he is likely, if he progress to the comparison of the characters of his specimens with the descriptive text, to find some puzzling interlocking of the species that have received names. He is sure, also, to find that the Latin names used are not those that he will find in common use in other botanical, horticultural, and pharmaceutical works that he is likely to consult, if his studies are technical, nor in the usual works relating to the flora of the eastern United States, if he be a botanist or botanically inclined. If already familiar enough

with the last-mentioned works to have acquired the habit of opening them readily to any desired family or genus of plants, he will also be annoyed because the sequence of families in the present work is not at all the same. These differences come from an effort to follow the sequence of groups of the great German treatise of Engler and Prantl, on the families of plants, and the nomenclature rules of the Botanical Club of the American Association for the Advancement of Science, as exemplified in the check list of the plants of eastern North America, published by its committee in 1893–94. Less objection will be made to the first than to the second of these changes from American custom, and, notwithstanding the difficulties of the undertaking, the authors of the book have been reasonably consistent in carrying out their ideas, so that it is going to prove an important factor in fixing the names preferred by the Neo-American school upon our plants; whether wisely or unwisely, it may be left for the future to show.

T.

Detmer and Moor's Physiology.[1] — The guide to practical laboratory work in a comparatively new field never comes amiss, and although several such guides in vegetable physiology are now in the hands of English-speaking teachers, this translation of Detmer's well-known *Praktikum* is a very welcome addition to their shelves. Nature study is frequently spoken of as a means of training the power of observation, but it is useful even to a greater extent as an educational factor, because it is an experimental study if properly pursued. Experimentation is largely a matter of personal ingenuity, like mechanical invention. In any direction, its foundations are laid by a small number of specially gifted men. But just as soon as their methods are understood, they may be applied by hundreds of other students to the solving of problems that are everywhere awaiting solution. Every book which, like Detmer's, outlines the general field of study and indicates the simplest apparatus and methods for attacking it, paves the way for the elaboration of refinements in the investigation of special subjects.

The topics treated are: the physiology of nutrition, and the physiology of growth and movements resulting from irritability. For these

[1] *Practical Plant Physiology.* An introduction to original research for students and teachers of natural science, medicine, agriculture, and forestry. By Dr. W. Detmer. Translated from the second German edition by S. A. Moor. 8°, pp. xix + 555. 184 illustrations. London, Swan, Sonnenschein & Co. New York, The Macmillan Company.

subjects, it is really an outline text-book, with directions for the practical demonstration of the facts which in an ordinary text-book stand simply as statements on authority. The student who has worked through it should be an expert and well-trained physiologist; if not, he may ask himself if he had not better turn his attention to other things. Unfortunately, the usual college elective does not allow time for making expert specialists, and the teacher who can devote but a short time to experimental physiology is likely to prefer one of the smaller and cheaper books for the direct guidance of his classes, though he cannot afford to allow them to do their work without constant reference to the more comprehensive handbooks, foremost among which stands this of Detmer.

T.

Minnesota Botanical Studies. — In January, 1894, *Bulletin No. 9 of the Geological and Natural History Survey of Minnesota* was begun as an occasional serial, the intention being to page the parts consecutively until a volume should be completed. In March, 1898, the twelfth part was issued, completing the first volume of the *Bulletin*. This volume contains fifty separate articles by twenty authors, dealing with a wide range of subjects, by no means confined to Minnesota geographically. It is illustrated by eighty-one plates or maps, and, as completed with its very full index, contains 1093 pages octavo. While unlimited praise cannot be bestowed on all of its contents, it is a valuable addition to the shelves of any botanical library which may be fortunate enough to possess it; but one cannot help wondering at the liberality of the State Survey of Minnesota in allowing so much matter wholly foreign to the usual purposes of such surveys to be published and distributed at the expense of the state.

T.

Edible Fungi. — To the already rather copious literature intended to facilitate discrimination between edible and poisonous fungi, Professor Farlow has recently added a small conservatively written article, which has been reissued in pamphlet form from the *Yearbook of the Department of Agriculture* for 1897.[1] Limiting himself to a very few species of both classes, which are accurately and yet tersely described in language which should be readily understood by any person of intelligence, the writer states a few rules which "should not be neglected by the beginner" in the following words: 1. Avoid

[1] Farlow, W. G. Some Edible and Poisonous Fungi. Washington, Government Printing Office, 1898. United States Department of Agriculture, Division of Vegetable Physiology and Pathology, *Bull. No. 15*. 18 pp., 10 pls., 8°.

fungi when in the button or unexpanded stage; also, those in which the flesh has begun to decay, even if only slightly. 2. Avoid all fungi which have stalks with a swollen base surrounded by a sac-like or scaly envelope, especially if the gills are white. 3. Avoid fungi having a milky juice, unless the milk is reddish. 4. Avoid fungi in which the cap or pileus is thin in proportion to the gills, and in which the gills are nearly all of equal length, especially if the pileus is bright colored. 5. Avoid all tube-bearing fungi in which the flesh changes color when cut or broken, or where the mouths of the tubes are reddish, and in the case of other tube-bearing fungi experiment with caution. 6. Fungi which have a sort of spider-web or flocculent ring round the upper part of the stalk should in general be avoided. To these simple rules, the observance of which should prevent any case of serious poisoning, though, as the writer states, it need not be assumed that a fungus is poisonous when it is merely indigestible, in consequence of the way in which it is cooked, numerous exceptions are possible in favor of aberrant edible forms; but they are for experts, and the caution is worth heeding that "the beginner is, of course, under the necessity of following the rules implicitly."

Another recent contribution to the same subject, and likewise an outcome of work done in the first instance in connection with the United States Department of Agriculture, is Dr. Taylor's *Student's Handbook*,[1] illustrated by a considerable number of plates, some of them colored, and containing recipes for preparing and cooking fungi, in addition to the customary keys and descriptions. T.

Natal Plants. — Under this title J. Medley Wood and Maurice S. Evans have begun the publication of a series of descriptions and figures, in quarto, of the indigenous plants of Natal, with notes on their distribution, economic value, native names, etc. The first part, recently issued, contains fifty figures and descriptions.

Professor Weed's Seed-Travellers[2] is one of the helpful little books designed to aid in nature-study, and if, as the author recommends, it is used in connection with observations upon the specimens it describes it can be made very useful. The illustrations, about half

[1] Taylor, Thomas. *Student's Handbook of Mushrooms of America, Edible and Poisonous.* Washington, A. R. Taylor, 1897, 1898. 8°.

[2] *Seed-Travellers, Studies of the Methods of Dispersal of Various Common Seeds.* By Clarence Moores Weed. Boston, Ginn & Co., 1898. 12°, pp. 53, ff. 36.

of which are original, probably have not come out quite as was intended, and it is not evident that most of them really serve the purpose of the book ; but two or three of them are very attractive.

The Grasses of Uruguay. — Prof. J. Archevalato has recently brought together in a large volume[1] the results of his study of this important group. The first twenty-eight pages are devoted to an organographic account of the grasses, some thirty-five pages are given to a discussion of what is called applied agrostology, and a very full index to both popular and scientific names occupies twenty-two pages. The remainder of the work consists of rather full descriptions of the species. Unfortunately, keys, which would have made the work more usable, have not been provided either for genera or species.

T.

The Metropolitan Parks of Boston. — The last report written by Charles Eliot,[2] which is very tastefully gotten up, contains much of interest to the landscape architect, many plates which ingeniously indicate by means of folding duplicate foregrounds the means of improving existing features, and an analysis of the commoner types of woodland scenery, which, with the accompanying reproductions of photographs, will also be of use to persons interested in plant communities as viewed by the œcologist.

T.

Botanical Notes. — The vegetation of the white sands east of the San Andreas Mountains, in southern New Mexico, on which Miss Eastwood had previously published, forms the subject of a note in the issue of *Science* of July 29, by Cockerell and Garcia, from which it appears that on these sands, 97% of the substance of which is gypsum (calcium sulphate), a considerable flora flourishes, some of the constituents of which appear to have undergone considerable modification in connection with their environment.

Professor Hitchcock, who for some years has been studying the weeds of Kansas, publishes, as *Bulletin No. 80 of the Experiment Station of the Kansas State Agricultural College*, a paper on their distribution. For the 209 species listed, the geographical distribution

[1] *Las Gramineas Uruguayas.* Montevideo, 1898. 4°, pp. 553, ff. 13 + lxxiii.

[2] *Vegetation and Scenery in the Metropolitan Reservations of Boston.* A forestry report written by Charles Eliot and presented to the Metropolitan Park Commission, Feb. 15, 1897, by Olmsted, Olmsted & Eliot, Landscape Architects. Lamson, Wolffe & Co., Boston, New York, and London, 1898.

of all within the limits of Kansas is indicated to the eye by the use of reduced maps, and for a number of species the range within the limits of the United States is shown in the same manner, so far as it was known.

The plants of the southeastern United States figured in Smith and Abbot's *Insects of Georgia*, a century ago, form the subject of a synonymic note by Britten in *The Journal of Botany* for August.

The collection, preparation, and shipment of exotic drugs forms the subject of a paper by Professor Planchon in a recent number of the *Bulletin de la Société Languedocienne de Géographie.*

As a result of several years' study, Burgerstein concludes that most of the pomaceous genera are separable by anatomical characters derivable from their secondary wood. His paper on the subject[1] includes a series of analytical keys based on the more reliable characters.

An interesting popular article by James Epps, Jr., on the cacao plant and its utilization, illustrated by a number of half-tone plates, appears in the *Proceedings and Transactions of the Croyden Microscopical and Natural History Club* for 1897, recently issued.

The Onagraceæ of Kansas form the subject of a paper by Prof. A. S. Hitchcock in a recent number of *Le Monde des Plantes.* Thirty-six species are enumerated, and for each is given a small map showing its distribution in the United States, and another indicating the counties of Kansas from which it has been reported.

The genus Bartonia is increased by Dr. Robinson, in the *Botanical Gazette* for July, by the addition of *B. iodandra*, a new species from Newfoundland, first collected in 1894 by Robinson and Schrenk, and more recently found some 200 miles from the original locality by Waghorne.

The eighth part of Professor Engler's "Beiträge zur Kenntnis der Aracæ," in Heft 3 of the *Botanische Jahrbücher* for the current year, consists in a revision of the genus Anthurium, in which a goodly number of species are described for the first time.

In his twelfth annual report as botanist of the Nebraska State Board of Agriculture, distributed in July as a reprint from the *Annual Report of the Board* for 1897, Professor Bessey gives a brief definition of the botanical regions of that state, as understood by Pound and Clements in their *Phytogeography of Nebraska*, and dis-

[1] Burgerstein, Alfred. Xylotomisch-systematische Studien über die Gattungen der Pomaceen. *Jahresberichte des k. k. zweiten Staatsgymnasiums im II. Gemeindebezirke in Wien, 1898.* Wien, 1898.

cusses at some length the forage problem as presented in each of the four principal regions recognized by them.

The grasses and forage plants and the forage conditions of the eastern Rocky Mountain region are discussed by Professor Williams in *Bulletin No. 12 of the Division of Agrostology of the United States Department of Agriculture.* The paper is illustrated by thirty figures.

Prometheus, No. 442, contains a readable article by Carus Sterne on Kohlenlager and Sumpfwälder, in connection with which should be read the paper on a fossil cypress swamp in Maryland, published by Arthur Bibbins in the August number of *The Plant World*, which is illustrated by an excellent reproduction of a photograph showing the stumps of the ancient forest as exposed at a beach on the Chesapeake.

Recent American papers on the archegoniates are : "The Gametophyte of *Botrychium virginianum*," by E. C. Jeffrey ;[1] "On the Leaf and Sporocarp of Pilularia," by Duncan S. Johnson ;[2] and "Conditions for the Germination of the Spores of Bryophytes and Pteridophytes," by Fred De Forest Heald.[3]

An interesting feature of *The Fern Bulletin*, a little quarterly published at Binghamton, N. Y., is promised in a series of papers by Mr. Alvah A. Eaton on the genus Equisetum with reference to the North American species, which it is proposed to illustrate with actual specimens of each species and variety treated.

Just's Botanischer Jahresbericht, which heretofore has been issued in rather large fascicles, some three years after the appearance of the papers of which it gives abstracts, begins its twenty-fourth year (containing the literature of 1896) in smaller sections, and, from the prompt appearance of the first of these, it is to be hoped that in future the useful abstracts which this indispensable handbook contains may all be available for reference by the end of the second year after the original papers have been published.

The Annals of Scottish Natural History for July announces that Miss Anne H. Cruickshank has given £15,000 for the formation and maintenance of a botanic garden in Old Aberdeen. The administration is placed in the hands of a board of six trustees, who are to use the proceeds of the gift to further botanical teaching and study in the University of Aberdeen, while permitting the public to visit the garden under suitable regulations. It is understood that Professor Trail will be the director of the garden.

[1] *University of Toronto Studies.* Biological Series, No. 1, 1898.
[2] *Botanical Gazette*, July, 1898. [3] *Ibid.*

A popular article on the plants of Australia, by Mr. Adcock, is printed in the *Journal of the Royal Horticultural Society* for July, which also contains an interesting article by E. F. im Thurn, entitled "Sketches of Wild Orchids in Guiana."

The Journal of the National Science Club for February last contains a short but interesting article on the Order Diapensiaceæ, by Margaret F. Boynton, illustrated by two plates of floral dissections and diagrams.

The New England Antennarias, long treated as representing a single very polymorphous species, form the subject of a paper by M. L. Fernald, published in the current volume of the *Proceedings of the Boston Society of Natural History*, in which six species and seven varieties are characterized.

The comparative anatomy of certain genera of the Cycadaceæ forms the subject of a paper, illustrated by one double plate, published in the July number of the botanical *Journal of the Linnean Society*, by W. C. Worsdell.

The Castilleias of the group of *C. parviflora* form the subject of a paper by M. L. Fernald in *Erythea* for May, in which a synoptical revision is given of those of northwestern America.

Calochortus clavatus, one of the best of the Mariposa lilies for garden purposes, is well figured in *Curtis's Botanical Magazine* for July.

Under the title "Floral Structure of Some Gramineæ," Lueders describes aberrant spikelets of *Panicum proliferum* and *Andropogon furcatus* in vol. xi of the *Transactions of the Wisconsin Academy*, recently issued.

A paper on the structure and development of Dendroceras, a genus of liverworts, is published by Prof. D. H. Campbell in the *Journal of the Linnean Society* for July.

West Indian Characeæ, collected by T. B. Blow, form the subject of a short paper by Henry Graves in the July number of the *Journal of the Linnean Society*, in which two Charas and three Nitellas are listed. One of the latter, *N. dictyosperma*, is described and figured as new.

To the earlier lists of Wisconsin parasitic fungi, by Trelease and Davis, Dr. Davis, in the eleventh volume of the *Transactions of the Wisconsin Academy*, adds a considerable number, among which is one new species, *Entyloma castaliæ* Holw., on Nymphæa and Nuphar.

PALEONTOLOGY.

Fossil Cephalopods in the British Museum. — Lists of published material in museums are a valuable aid to investigators, and such lists are welcomed by museum men. The present list[1] comprises about nine hundred and fifty entries of types and figured specimens, presenting a graphic testimonial to the richness of the collections of cephalopods in the British Museum. The list is arranged alphabetically by genera ; in the index the arrangement is alphabetical by species, so that any given form is readily found. This is an excellent system for such a list. Frequent critical notes give special information in regard to specimens or published figures. Specimens are listed under their names, as originally described in the publications cited. It would have been desirable in addition to have included in brackets, or otherwise, the current generic names where they differ.

A defect in the list is the fact that types are not indicated as such. A type is the specimen or specimens from which a new species or genus was described, and as such should be distinguished from other published material. "Orthocera" and "Orthoceras" are listed separately as if they were two genera. Both names are the same word, the difference being insufficient for generic distinction. By the system adopted, the same species in a genus become separated in an artificial way, as in the case of "*Orthocera politum*" and "*Orthoceras politum.*" The species might have been listed under Orthoceras, indicating the original spelling where necessary. A few specimens are included, which, as the author says, have been erroneously referred to the Cephalopods, such as "*Helicoceras elegans* . . . a Gastropod." A recent *Nautilus pompilius* is also listed. In a catalogue of fossil Cephalopods, it would have been better to have put these associated forms at the end of the list, rather than in the body of the text.

R. T. J.

PETROGRAPHY AND MINERALOGY.

Basic Rocks in Italy. — Near Ivrea, a small town on the Dora Baltea in Italy, is a small area of basic eruptive rocks that have recently been studied by Van Horn.[2] The principal type is a norite.

[1] Crick, G. C. List of Types and Figured Specimens of Fossil Cephalopods in the British Museum (Natural History). London, 1898.

[2] *Min. u. Petrog. Mitth.*, Bd. xvii.

This passes by addition of quartz into a rock called by the author a quartz-hypersthene-diorite, and by addition of brown hornblende into a type called a hornblende-gabbro. The norite consists of basic plagioclases, hypersthene, diallage, brown and green hornblende, biotite, a few accessory minerals, and decomposition products of the plagioclase. The diallage and hypersthene are often in parallel intergrowths. In the quartz-hypersthene-diorite biotite is more common than it is in the norite. Brown hornblende is absent. In the hornblende-gabbro brown hornblende is more abundant than the pyroxenes. It is the characteristic constituent. Its prismatic angle is $124° 18'$ and its density 3.217–3.222. The mineral is pleochroic with $\mathfrak{a}$ = yellow; $\mathfrak{b}$ = reddish brown; $\mathfrak{c}$ = yellowish brown. The extinction $\mathfrak{c} \wedge c$ varies between $14° 30'$ and $15° 30'$. A portion separated from the rock powder yielded when analyzed:

SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	H_2O	Total
39.58	14.91	4.01	10.67	tr.	13.06	11.76	2.87	.62	2.79 =	100.27

This gives in calculation very nearly the formula $(HKNa)_2 (MgFeCa)_4 (AlFe)_2 Si_4O_{16}$, or in its generalized form $R'_2 R''_4 R'''_2 (SiO_4)_4$, a formula unusual for amphibole. The author suggests that there may be a group of amphiboles that are orthosilicates, though the greater number of them are unquestionable metasilicates. The three rock types described grade into each other by almost imperceptible changes, the gabbro and the diorite being peripheral forms of the norite. Analyses of the three rocks follow:

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O	
Horn.-gabbro	39.84	.08	19.71	7.73	8.89	tr.	7.33	13.52	1.59	.53	tr.	.86 =	100.08
Uorite . . .	49.95	.69	19.17	4.72	6.71	tr.	5.03	9.61	3.13	.74	tr.	.09 =	99.84
Qu.-Hyper.-diorite . .	56.45	tr.	20.15	4.36	5.00	tr.	2.66	6.59	2.95	1.00	.24	1.61 =	101.02

The Rocks Associated with the Iron Ores in Switzerland. — Among the rocks associated with the iron ores in Canton Grisons, Switzerland, are several that are extremely interesting, according to Bodmer-Beder.[1] Among them are a porphyritic quartz-diorite, auralite-porphyrite, and a quartz-biotite porphyry. The latter has a microgranitic groundmass and large phenocrysts of orthoclase, and smaller ones of oligoclase, quartz, and biotite. The groundmass consists of quartz and plagioclase, muscovite, zoisite, sericite, sphene, epidote, apatite, sillimanite, garnet, magnetite, hornblende, biotite, and secondary substances. Some of the quartz phenocrysts are crossed by

[1] *Neues Jahrb. f. Min.*, etc., Bd. xi, p. 217.

twinning lamellæ produced along slipping planes parallel to the rhombohedron. In addition to the minerals above mentioned there are also present in the rock in small quantity allanite, anatase, brookite, ilmenite, zircon, an inclusive of sodalite in one of the quartz phenocrysts, some fluorite and barite. The analysis following shows the presence also of some other substances not detected by the microscope.

SiO_2	Al_2O_3	Fe_2O_3	FeO	Fe	K_2O	Na_2O	CaO	MgO	BaO	Cu	Pb	SO_3	S	BO_2O_3	TiO_2	P_2O_5	Cl	F	H_2O
68.89	14.05	2.18	1.43	.23	4.30	4.56	2.15	.83	.58	.03	.04	.30	.26	.38	.23	.03	.07	.05	.41 = 101.00

The ores of the district are mainly magnetite, mixed with small quantities of pyrite, hematite, limonite, chalcopyrite, malachite, and cuprite, and associated with tourmaline, calcite, apatite, and the fresh and altered constituents of diorite. They are thought to be differentiation products of the diorite, while the associated minerals are the result of later dynamic and pneumatolytic processes.

Swiss Schists. — In the course of a study of the geology of the Val di' Mortirolo in the Alps, Salomon[1] met with several rocks of sufficient interest to merit detailed investigation. These are adamellites, hornblende-diorites, potassium and sodium gneisses, and micaschists, exhibiting in a very clear manner the effects of mountain-making forces. These effects are expressed in different ways, according to the nature of the rock acted upon, either as bending, as crushing, or in chemical transformations. The adamellite has yielded a "microcline-augen-gneiss," and the hornblende-diorite a clinozoisite-albite-amphibolite. After examining critically the effect of the mountain-making forces in deforming the mineral components of the rocks studied, the author concludes that the bending of great (rock) masses without fracture hardly ever occurs, but that fractureless bending and deformation with fracture may unite in different proportions, depending upon the mineral composition of the rock effected, the severity of the pressure and the duration of its action, to produce rock-bending. A special form of fractureless deformation is effected through the chemical transformation of minerals and the consequent transportation of their material particle by particle. This view of dynamical metamorphism is not very different from that of Van Hise, as discussed in the article referred to below.

[1] *Neues Jahrb. f. Min.*, etc., Bd. xi, p. 355.

Nomenclature of Contact Rocks.[1] — Salomon, in his discussion of the geological relations of the granite massifs of the southern Alps lying between Piedmont and the boundary of Hungary, finds occasion to refer briefly to many contact rocks. The confusion in the nomenclature of this most interesting of rock-groups leads him to suggest a simplification in the method of naming them. The less altered phases in the outermost zones of contact action he would call by the names of the original rocks from which they were formed, adding the word "contact" as a prefix, as "contact-sandstone"; for the more highly metamorphosed phases, he would use "hornfels," with a suffix indicating its mineral character. Thus we would have a "hornfels-gneiss," a "hornfels-micaschist," etc. The names edolite, astite, aviolite, and seebenite are proposed for combinations of mica and feldspar, mica and andalusite, mica and cordierite, and cordierite and feldspar.

A large number of brief descriptions of the granite of the massifs, and of the metamorphic rocks surrounding them, are scattered through the article, which is geological rather than petrographical.

Petrographical Notes. — Basalt occurs south of New-Lars and north of Kasbek in the Caucasus. Hibsch[2] reports the rock from both localities to contain phenocrysts of quartz and feldspar in a basaltic matrix composed largely of glass. The quartz phenocrysts are surrounded by aureoles of augite. The phenocryst plagioclases consist of rounded acid nuclei of the composition AbAn enclosed in peripheral zones of a more basic feldspar, Ab_2An_3, of the same composition as the plagioclases in the groundmass. Many augite crystals, also, are built around nuclei of hypersthene. Hibsch explains the phenomena as due to the presence in the basalt of foreign quartz, acid feldspar, and hypersthene grains obtained from an andesite.

Cohen[3] reports the existence of a tourmaline-hornfels in the contact zone around the granite of Sea Point in the Cape States.

The subject of metamorphism and the metamorphic rocks is treated critically by Van Hise[4] in an essay that discusses the physico-chemical and the dynamic-mass, and molecular principles involved in the production of highly crystallized rock types from glassy and clastic forms. The nature of the essay prevents its successful abstraction, as it is itself the abstract of a fuller treatise on the same subject.

[1] *Min. u. Petrog. Mitth.*, Bd. xvii, p. 143.
[2] *Ibid.*, p. 285. [3] *Ibid.*, p. 287.
[4] *Bull. Geol. Soc. Amer.*, vol. ix, p. 269.

Meteorites.[1]— The writer believes that the iron meteorites, known as siderites, are of the same nature as the small specks of iron that occur in nearly all the stony meteorites; that they represent the product of a slower crystallization of the meteoric mass under specially favorable, and therefore rarely occurring, conditions; that this explains the fact that stony meteorites are of much more frequent occurrence than siderites. Moreover, he believes that a meteor containing these iron concretions is more subject to rupture by explosion on reaching our atmosphere, the nodules forming points of weakness; and that therefore the iron nodules are generally freed from their stony matrix before falling, and may arrive at the earth's surface at a distance from the lighter constituents. The Estherville fall is quoted as a good example of such a case. He further points out that meteorites with a deeply pitted surface are coarsely crystalline, and contain relatively large troilite nodules, the pits being probably due to the tearing away of portions of the mass along the easy fracture planes of the large crystal individuals, whereas in the masses with finer texture such fracture would be less likely, and a smooth surface would be formed.

The siderites secured by Mr. Ward[2] while in Australia in 1896 are from the following localities: (1) 200 miles southeast of Roebourne in northwest Australia, weight 191½ lbs.; (2) 10 miles south of Ballinoo, West Australia, weight 93 lbs.; (3) three miles north of Mungindi P. O., New South Wales, two masses of 62 and 51 lbs.; (4) Mooranoppin, West Australia, weight 2½ lbs. All four irons are octahedral in structure, No. 3 being remarkable for the ease with which Widmanstätten etching figures of great clearness and beauty may be developed.

The siderite described by Preston was found in the prairie seven miles south of San Angelo, Tom Green County, Texas. Its weight was 194 lbs., and the structure noticeably octahedral, a broken surface exhibiting large cleavage faces. It showed a few troilite nodules and veins of a lustrous graphitic-looking mineral. Its composition, together with that of three of the Australian irons, is shown in the following table of analyses by Mariner & Hoskins, Chicago, Ill.:

[1] Preston, H. L. On Iron Meteorites as Nodular Structures in Stony Meteorites. *Am. Journ. Sci.*, vol. clv (1898), p. 62.

[2] Ward, H. A. Four New Australian Meteorites. *Ibid.*, p. 135. Preston, H. L. San Angelo Meteorite. *Ibid.*, p. 269.

	(1) Roebourne.	(2) Ballinoo.	(3) Mungindi.	San Angelo.
Fe	90.914	89.909	90.307	91.958
Ni	8.330	8.850	8.230	7.860
Co	0.590	0.740	1.360	trace
P	0.156	0.501	0.093	0.099
C	trace	trace	0.010	trace
Si	0.010	trace?	trace?	0.011
S	trace	trace	trace	0.032
Mn	trace?	—	—	trace?
Cu	—	trace	—	0.040
	100.00	100.00	100.00	100.00
Specific Gravity	7.78	7.8	7.4	7.7

Mineralogical Notes. — Pratt[1] describes the following minerals from North Carolina: *Cyanite*, from the farm of Tiel Young, Yancey County, in large, grass-green crystals showing the forms: *c*, 001; *b*, 010; *a*, 100; *m*, 110; *M*, 110; *Q*, 120; *t*, 520; the last new for the species. Pale-green cyanite has been found at a number of localities in the region named, as well as at Graves Mt., Ga., where it is accompanied by rutile. *Zircon*, from New Stirling, Iredell County, in large crystals of pyramidal habit showing the forms: *a*, 100; *m*, 110; *p*, 111; *v*, 221; *x*, 311. *Anorthite*, from Buck Creek, Clay County, forming with olivine a mass of troctolite rock, the crystals of feldspar varying in size up to an inch and a half long and three-quarters of an inch broad. Its specific gravity is 2.699 to 2.744, and its composition almost that of a pure anorthite, as shown by the appended analysis.

Farrington[2] describes crystals of datolite from Guanajuato, Mexico, associated with calcite and quartz. The crystals are small, transparent, colorless, faces fairly bright and sharp; 17 forms were determined, none of them new to the species. The crystals assume three types of habit, one of which closely simulates that of datolite from Bergen Hill, described by Dana, being tabular parallel to *x*, 102. One crystal showed a merohedrism simulating inclined-faced hemihedrism.

[1] Pratt, J. H. Mineralogical Notes on Cyanite, Zircon, and Anorthite from North Carolina. *Am. Journ. Sci.*, vol. clv (1898), p. 126.

[2] Farrington, O. C. Datolite from Guanajuato. *Ibid.*, p. 285.

SCIENTIFIC NEWS.

Fresh-water investigation in Switzerland is in charge of a "Limnological Commission" of the Swiss "Naturforschende Gesellschaft." This Commission was under the presidency of Prof. F. A. Forel, but for a number of years of late the position has been occupied by Prof. F. Zschokke, of the University of Basel. At present the Commission is engaged principally in an exhaustive examination of the Vierwaldstättersee. This work is in charge of a special committee of which also Professor Zschokke is chairman. The investigations have been carried on for three years, and are in full progress at present; they include work along physical, chemical, botanical, and zoological lines. The physical report has been published, and two zoological papers — upon the plankton and the Mollusca — are ready for the press. It is hoped that the entire project will be completed in ten years. The results are published in the *Berichten der Naturforschenden Gesellschaft zu Luzern.* There is a finance committee that secures the funds needed for the prosecution of the work by subscriptions from the authorities, societies, and individuals interested in the locality. Lake Zürich is also being investigated by the city of Zürich, in conjunction with the University and its associated polytechnic schools. The zoological part of the work is in charge of Dr. G. Heuscher, and the botanical side is attended to by Prof. C. Schröter. The Limnological Commission also has an interest in these explorations. The individual work of Prof. F. A. Forel upon Genfersee and that of the International Commission on Bodensee should also be mentioned.

Profs. E. L. Mark and W. M. Davis, of Harvard, and Henry F. Osborn, of Columbia, are spending their sabbatical year in Europe.

Osbert Salvin, the well-known ornithologist, and co-editor with Frederic Godman of the *Biologia Centrali Americana,* died near Haslemere, England, at the age of 63. He was a graduate of Cambridge, made three trips to Central America, and was for several years editor of the ornithological journal, *The Ibis.* He was author, either alone or with an associate, of about 125 papers.

The University of California has been presented by the Alaskan Commercial Company of San Francisco with the large and valuable

collections which the company has been accumulating for many years. The ethnological portion of the collection is especially rich, and doubtless one of the best in existence. The collection also embraces fossil remains of mammoth, and many skins and mounted specimens of birds and mammals and invertebrates of the Alaskan region.

Recent Appointments: Miss Agnes May Claypole, of Wellesley, assistant in histology and comparative physiology in Cornell University. — Dr. F. E. Clements, instructor in botany in the University of Nebraska. — Dr. W. McM. Woodworth has been appointed assistant in charge of the Museum of Comparative Zoology at Cambridge.

Appointments to fellowships: University of Nebraska, Albert B. Lewis and Charles C. Morrison in zoology, Cassius A. Fisher in geology, Albert T. Bell and Cora F. Smith in botany. — Johns Hopkins University, Dr. Gilman A. Drew, Bruce fellow in biology.

The following appointments to fellowships have been made by Harvard University: Parker fellowship for non-resident study, Frank Watts Bancroft, zoology. — Morgan fellowships, Amadeus William Grabau, paleontology; Edward Charles Jeffrey, botany.

The following appointments have been made at the University of Illinois: Mr. C. W. Young, B.S., assistant in botany; Mr. Wallace Craig, B.S., assistant in the State Laboratory of Natural History at Illinois Biological Station, Havana, Ill.; Mr. E. B. Forbes, B.S., field entomologist of the State Laboratory of Natural History; Dr. J. P. Hylan, assistant professor of psychology; Dr. C. A. Kofoid, assistant professor of zoology. — Mr. C. F. Hottes, M.S., assistant in botany, goes to Bonn and Leipzig for botanical study.

Recent deatns: Dr. Theodor Eimer, professor of zoology in the University of Tübingen, and a well-known advocate of Neo-Lamarckian views, May 29. — C. W. A. Hermann, mineralogist, in New York, June 21, aged 97.

PUBLICATIONS RECEIVED.

Barnes, C. R. Plant Life, Considered with Special Reference to Form and Function. New York, Henry Holt & Co., 1898. x + 428 pp., 8vo, 415 figures. $1.12.

Frič, Ant. Studien im Gebiete d. böhmischen Kreideformation. Palaeontologische Untersuchungen d. einzelnen Schichten. VI. Die Chlomeker Schichten. Prag, Fr. Rivnâc, 1897. 83 pp., 124 figures. From *Arch. f. Naturw. Landesforschung von Böhmen*. Bd. x, No. 4. — Frič, Ant., and Vávra, V. Untersuchungen ü. d. Fauna der Gewässer Böhmens. III. Untersuchungen zweier Böhmerwaldseen, des Schwarzen f. d. Teufelssees. Prag, Fr. Rivnâc, 1897. 73 pp., 33 figures. From *Arch. f. Naturw. Landesforschung von Böhmen*. Bd. x, No. 3. — Hill, R. T. The Geological History of the Isthmus of Panama and Portions of Costa Rica. Based upon a reconnoissance made for Alexander Agassiz, with special determinations by W. H. Dall, R. M. Bagg, T. W. Vaughan, J. E. Wolff, H. W. Turner, and Ahe Sjögren. *Bull. Museum Comp. Zoöl.* Vol. xxviii, No. 5, 134 pp., 19 plates, June. — Kain, S. W. List of Recorded Earthquakes in New Brunswick. Compiled from Published Works and from Private Information. From *Bull. Nat. Hist. Soc. of N. B.* Vol. xvi, 1898.

Annales d. l. Société Belge de Microscopie. Tome xxii, Fasc. 2. — *Annotationes Zoologicæ Japonenses.* Vol. ii, Pt. ii, 1898. — *Geographical Journal.* Vol. xii, No. 1, July. *Johns Hopkins Hospital Reports.* Vol. vii, No. 3. Report in Pathology, Chas. R. Bardeen. A review of the pathology of superficial burns, etc. — *La Nuova Notarisia.* Ser. ix, July. — *Michigan State Agricultural College.* Report of the Botanical Department. *Michigan State Agricultural College, Experiment Station.* Elementary Science Bulletins 1–4. W. J. Beal, Study of Beans and Peas before and after Sprouting. Study of Wheat and Buckwheat before and after Sprouting. Study of the Seeds of Timothy and Red Clover before and after Sprouting. Observations on the Leaves of Clovers at Different Times of Day.

(*Number 381 was mailed September 27.*)